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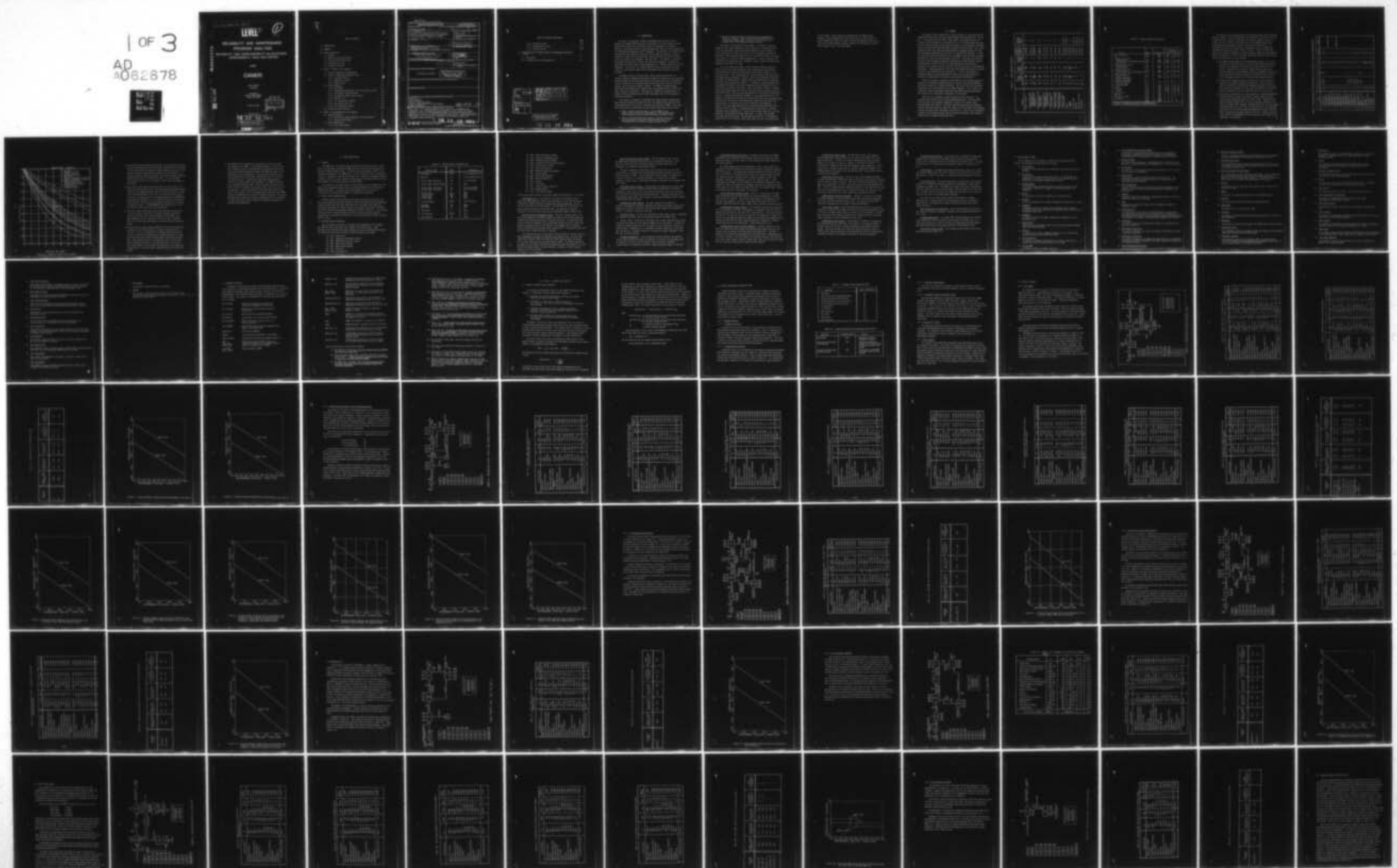

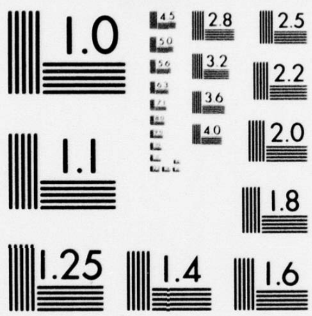

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LEVEL II

RELIABILITY AND MAINTENANCE PROGRAM ANALYSIS

RELIABILITY AND MAINTAINABILITY ALLOCATIONS, ASSESSMENTS ANALYSIS REPORT

FOR

CAMDS

FINAL REPORT
VOLUME I

Submitted to
TOOELE ARMY DEPOT
Tooele, Utah 84074

APRIL 23, 1976

Prepared under
Contract No. DAAG-49-75-C-0135

TRW / ENVIRONMENTAL ENGINEERING DIVISION

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study: (1) Assessed CAMDS at the system level to determine the adequacy of the building block design processing rates to meet the target production rates, (2) Performed RAM analyses at the building block level to determine the validity of design processing rates and (3) Identified potential RAM problem areas, assess the significance of the problem areas, and recommend corrective action.

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1.0 INTRODUCTION

The Army is developing a Chemical Agent/Munitions Disposal System (CAMDS) for complete demilitarization and disposal of lethal chemical agents and munitions within the constraints of total containment of hazardous materials, impeccable safety to operating personnel and the civilian population, and stringent environmental control standards. The munitions to be demilitarized include artillery projectiles with and without explosive bursters, chemical rockets with explosives and propellant, chemical mortars and land mines with explosives, bombs, ton containers, and spray tanks. The CAMDS is intended to disassemble the munitions, destroy the explosive components, incinerate or neutralize the lethal agents, and decontaminate all residual hardware and inert components. The system is to embody absolute safety precautions to prevent release of the chemical agents to the environment and to protect operating personnel.

The CAMDS consists of specialized, remote-controlled machinery for removing explosive components and chemical agents from munitions, two continuous furnace systems for thermal deactivation of energetic materials and decontamination of metal parts, a chemical agent destruction plant, material transport systems, and the required support systems. The CAMDS is being designed, fabricated, and installed on a modular basis by Edgewood Arsenal, Tooele Army Depot, and their contractors. The plant is scheduled to be operational by October 1976 at the South Area of Tooele Army Depot and will be operated by Government personnel.

This report is prepared in compliance with CDRL Sequence Item A002 and Data Item Description DI-R-3535/R-103-2/M, and addresses the results of the maintainability and reliability assessment and analyses of CAMDS. The assessment and analysis was performed in three phases with objectives as follow:

- Phase I System Level Assessment: Assess CAMDS at the system level to determine the adequacy of the building block design processing rates to meet the target production rates.
- Phase II Building Block Level Analysis: Perform reliability and maintainability analyses at the building block level to determine the validity of design processing rates.

- Phase III Identification of Problem Areas and Recommended Corrective Actions: Identify potential maintainability and reliability problem areas, assess the significance of the problem areas, and recommend corrective action.

This report is structured in two volumes. In Volume I, Section 2 summarizes the study findings; Section 3.0 presents a broad description of the building blocks and munition demilitarization line configurations, definitions of terms used, and a list of documents reviewed and utilized in this assessment; Sections 4.0, 5.0 and 6.0 presents the results of the Phase I, II and III efforts respectively. Volume II contains the reliability and maintainability worksheets, charts, graphs and backup data generated by the Phase II study.

It is to be noted that Phase I and II employ different production rates; Phase I uses actual predicted rates determined by the capacity limiting building blocks (the system bottle necks) while Phase II uses the target rates. This discrepancy has a minor impact on the study results and stems from the following. Phases I and II were performed in parallel with Phase II leading Phase I because the system availabilities generated in Phase II were necessary for Phase I. In Phase II, system availabilities were determined based on the target production rates which were the best information available at that time. Late in the Phase I effort, it became clear that target production rates are not going to be attained by most of the munition lines, thus casting some question on the utility of the Phase II results. Through closer analysis however, it was determined that the differences in production rate does not significantly alter the predicted system availabilities since not all building blocks comprising a munition line configuration are affected by cyclical reliability considerations. In general, only the second decimal place of the predicted availabilities is altered by use of "actual" vs target production rates which is entirely reasonable since differences in "actual" versus target rates are, with one exception (105 mm M360 Cartridges, GB) small. At worst (105 mm M360 Cartridges, GB with Burster), the predicted availability is increased by roughly 7% by use of "actual" rates, which does not alter the conclusions of this study. Hence, with the concurrence of the CAMDS Project Officer, it was concluded that use of the Phase II results based on target production rates will result in minor discrepancies which do not bear on the study finding, and that recasting of the Phase II results using "actual" rates is not warranted.

2.0 SUMMARY

The results of the system level analysis (Phase I), indicate that the target production rates for most munition/agent configurations will not be met. The exceptions are the Bulk Items (bombs, spray tank and ton container), the 8" Projectile, and the M23 Mine. This determination was made by first assessing each system required to demil a munition/agent configuration to identify the interrelationship between building blocks. The system processing rates were then determined based on equipment capacities without considering downtime due to failure or scheduled maintenance. A three shift/day-five day week operation with a debugged system and fully trained personnel was used for the operational baseline. The system availability resulting from unscheduled downtime stemming from random failures and the time required to effect repairs was then determined and modified as appropriate to account for other availability factors such as environmental conditions. System production levels were then determined based on processing rates and estimated system availability. Finally, the impact of scheduled downtime on these production levels was then determined as a function of operational and preventive maintenance requirements.

Table 2-1 presents a summary of downtimes for each munition/agent configuration including allowable downtime, estimated unscheduled downtime, and time available for scheduled downtime. As can be seen, the estimated unscheduled down often exceeds the allowable downtime. This results in a reduction in daily production capability even before scheduled downtime for preventive or operational maintenance is considered.

Table 2-2 is a summary of system production rate estimates. The estimates shown here do not include scheduled downtime. The individual munition demil line analyses presented in Section 4-3 address these scheduled downtime effects. The only identified operational maintenance actions that would require system shut down are for the Rocket Demil Machine and the Projectile Demil Equipment, see Table 4-2. There are no identified preventive maintenance actions requiring system shut down, that cannot be scheduled for a weekend maintenance shift.

Table 2-1. Sytem Downtime Estimates

Munition	Agent	Daily Target Production Rate	Maximum Daily System Capability	Allowable Daily Downtime (hrs)	Estimated Daily Unscheduled Downtime (h rs)	Available Scheduled Downtime (hrs)
Rocket, 115 mm, M55	GB	400	384	0	3.52-4.53	0
	VX	400	384	0	3.77-4.76	0
Cartridge, 105 mm, M360						
without Bursters	GB	1000	720	0	3.92-4.91	0
without Bursters, with Welded Burster Well	GB	1000	720	0	4.00-4.98	0
with Bursters	GB	1000	720	0	6.32-7.48	0
Projectile, 155 mm, M121A1						
without Bursters	GB	650	720	2.3	3.29-4.31	0
without Bursters	VX	650	720	2.3	3.53-4.53	0
Projectile, 155 mm, M121						
without Bursters	GB	650	720	2.3	3.53-4.53	0
without Bursters, with Welded Burster Well	GB	650	720	2.3	3.37-4.38	0
Projectile, 155 mm, M122 without Bursters	GB	650	720	2.3	3.37-4.38	0
Projectile, 155 mm, M110 Mustard with Bursters	H	650	672	2.3	4.96-5.89	0
Projectile, 155 mm, M104 Mustard with Bursters	HD	650	672	2.3	4.96-5.89	0
Projectile, 8", M426 without Bursters	GB	400	480	4	2.84-3.88	1.16-.12
M23 Mine	VX	800	960	4	2.78-3.82	1.22-.18
4.2" Mortar M2/M2A1	HD	1000	1200	4	5.27-6.19	0
	HT	1000	1200	4	5.27-6.19	0
MC-1 Bomb, 750#	GB	24	28	4	1.76-2.85	2.24-1.15
MK94 Bomb	GB	24	28	4	1.78-2.87	2.22-1.13
Spray Tank, TMU - 28/B	VX	4	4	4	2.04-3.12	1.96-.88
Ton Container	GB	5	6	4	1.78-2.87	2.22-1.13
	VX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2-2. System Production Estimates

Munition	Agent	Availability*	Daily Production Rate (Items/Day) Target	Estimated**
Rocket, 115 mm, M55	GB	.8540	400	311 - 327
	VX	.8439	400	307 - 323
Cartridge, 105 mm, M360				
without Bursters	GB	.8375	1000	572 - 602
without Bursters, with Welded Burster Well	GB	.8341	1000	570 - 600
with Bursters	GB	.7384	1000	471 - 495
Projectile, 155 mm, M121A1				
without Bursters	GB	.8632	650	590 - 620
without Bursters	VX	.8542	650	584 - 614
Projectile, 155 mm, M121				
without Bursters	GB	.8632	650	590 - 620
without Bursters, with Welded Burster Well	GB	.8609	650	588 - 619
Projectile, 155 mm, M122				
without Bursters	GB	.8606	650	588 - 619
Projectile, 155 mm, M110 Mustard with Bursters	H	.7942	650	507 - 533
Projectile, 155 mm, M104 Mustard with Bursters	HD	.7942	650	507 - 533
Projectile, 8", M426				
without Bursters	GB	.8830	400	402- 423
M23 Mine	VX	.8846	800	806 - 848
4.2" Mortar	HD	.7814	1000	890 - 936
M2/M2A1	HT	.7814	1000	890 - 936
MC-1 Bomb, 750#	GB	.9277	24	25 - 26
MK94 Bomb	GB	.9268	24	25 - 26
Spray Tank, TMU - 28/B	VX	.9159	4	4
Ton Container	GB	.9272	5	5
	VX	.9168	5	5
	HD	.9409	5	5

*Portion of time system is not affected by unscheduled downtime.
**Based on no scheduled downtime during a 3 shift/day operation.

The results of the building block level maintainability and reliability analysis (Phase II) are too voluminous for presentation here and are listed in Section 5.2.4. Table 2-3 and Figure 2-1 however, summarize the maintainability and reliability characteristics of the CAMDS munition lines as determined by evaluation of their constituent building blocks. As indicated by Table 2-3, the low mean time between failures coupled with the moderately high mean time to repair results in system availabilities which do not permit achievement of target production goals for most munition demil configurations. A few of the more significant findings of the building block level analysis are as follows:

- The CAMDS concepts appear to be fundamentally sound in its mission to dispose of chemical munitions in a safe and expedicious manner. However, the soundness of the functional designs have yet to be proven. Findings of this analysis suggest that the design approaches adopted in some instances results in equipment availabilities which degrade the effective production capabilities to levels far short of standards necessary to achieve target production rates.
- Indiscriminant redundancy does not appear to be a cost effective approach for improving equipment availability. Case studies as noted in Section 6.2 indicate that complete redundancy of the MPF, DFS and ADS (for example), increases the availability of the 105 mm M360 Cartridge GB with burster munition demil line by only 1½%.
- Predicted system availaiblities are sensitive to the maintainability factors utilized to gauge the effects of agent protective suits and equipment maintenance access on repair times. Maintainability factors employed ranged from 1.5 to 4.0, and were, because of the absence of better data, assumed somewhat arbitrarily. If for example, these maintainability factors can be reduced by 50%, the predicted availability of the 105 mm, M360 Cartridge GB with burster munition demil line would be increased from 0.74 to 0.85. Clearly, acquisition of better maintainability factors based on actual tests on the CAMDS gear, is warranted.

Table 2-3 Maintainability of Munition Demil Lines (Based on Target Production Rates)

Munition	Agent	Explosive	Propellent	MTBF (Hr)	MTTR (Hr)	Remarks
1. M55 Rocket 115mm	GB	Comp. B	M28	48.5	8.2	
2. M55 Rocket 115mm	VX	Comp. B	M28	45.5	8.2	
3. Cartridge 105mm M360 Without Burster	GB	-	-	41.9	7.9	
4. Cartridge 105mm M360 Without Burster	GB	-	-	40.9	8.0	Welded Burster Well
5. Projectile 155mm M121A1 Without Burster	GB	-	-	48.7	7.5	
6. Projectile 155mm M121 Without Burster	GB	-	-	48.7	7.5	
7. Projectile 155mm M121 Without Burster	GB	-	-	47.8	7.5	Welded Burster Well
8. Projectile 155mm M122 Without Burster	GB	-	-	48.7	7.5	
9. Projectile 8" M426 Without Burster	GB	-	-	55.9	7.2	
10. Projectile 155mm M121A1 Without Burster	VX	-	-	45.6	7.6	
11. Cartridge 105mm M360 With Burster	GB	Tetrytol	M1	24.6	8.7	
12. Projectile 155mm M110 With Burster	H	Tetrytol	-	32.5	8.3	
13. Projectile 155mm M104 With Burster	HD	Tetrytol	-	32.5	8.3	
14. Mine, 2 gallon, M23	VX	Comp. B.	-	53.2	6.7	
15. Cartridge, Mortar, 4.2" M2/M2A1	HD	Tetryl	M6	31.1	8.6	
16. Cartridge, Mortar, 4.2" M2/M2A1	HD	Tetryl	M6	31.1	8.6	
17. Bomb, 750#, MC-1	GB	-	-	99.3	7.3	
18. Bomb, MK94	GB	-	-	98.4	7.4	
19. Tank, Spray, TMU-28/B	VX	-	-	86.5	7.6	
20. Ton Container	GB	-	-	99.1	7.4	
21. Ton Container	VX	-	-	87.2	7.5	
22. Ton Container	HD	-	-	123.7	7.2	

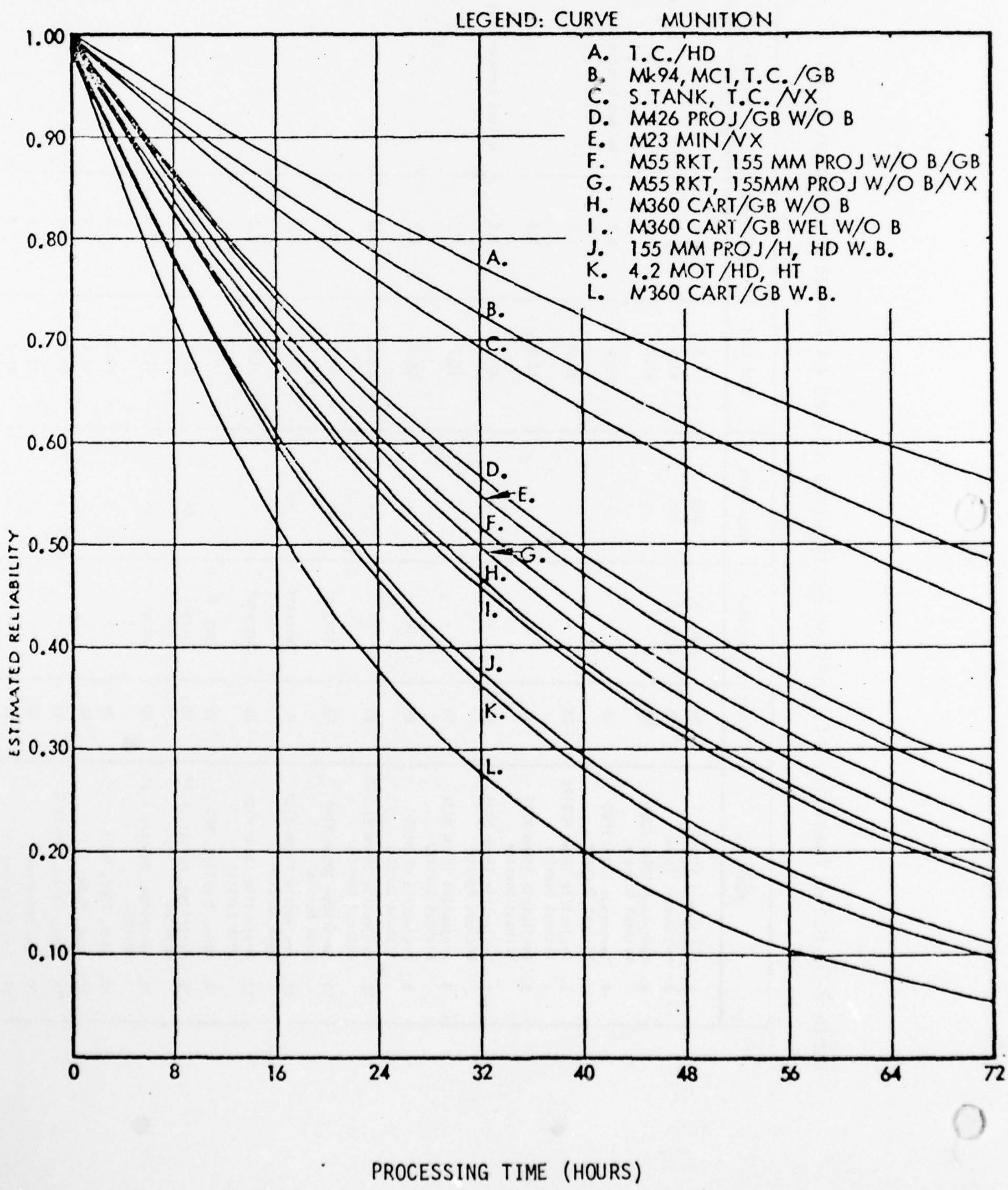

Figure 2-1. Summary of Reliability Estimation by Munition Type

- The analysis shows that the munition demil line involving the least number of Building Blocks (8), the least complicated Building Blocks, one of the more easily disposed of agents (mustard), and one of the slowest (low-cyclic application) processing rates (0.25/hr), i.e., the ton container containing mustard, also has the highest expected probability of success (reliability) curve. The related MTBF and Availability are also the highest at 123.7 hours and 0.945, respectively.

- The analysis shows that the munition demil line involving a high number of Building Blocks (18), the more complicated Building Blocks (the ECC and its demil machine (PDM), the PPD, both hydraulic power units, many MHE elements, etc.), one of the more difficult agents to dispose of (GB), and one of the higher (high-cyclic application) processing rates (28/hr), i.e., the 105 mm Cartridge with Bursters containing GB, also has the lowest expected probability of success (reliability) curve. The related MTBF and Availability are also the lowest at 24.6 hours and 0.738 respectively.

- Taken as a group, the analysis shows that the munition processes involving the bulk items have the highest expected probability of success (reliability) curve and highest related MTBF values when compared with the processes involving the other munitions. There is distinct open area between the curves depicting these two groups.

- The mean-time-to-repair/replace (MTTR) shows a wide variation from Building Block to Building Block (a range of approximately 2 to 13 hours). This is attributable to considerations which dictate the use of protective clothing (which impede maintenance) in some building blocks while other building blocks require no protective gear. Also accessibility will be much more restrictive in some building blocks than others. The MTTR variation is relatively small with regard to the different munition demil lines, where the average MTTR is 7.76 hours with a standard deviation of 0.532 hour (6.9%).

- The purpose of this analysis was to predict "a priori" certain characteristics of CAMDS. The accepted methods of accomplishing this involves the use of recorded data and experience which have been obtained from comparable systems and components under similar conditions of use and operation. These data and experience are then applied to the system under consideration by the "principle of transferability." The two most applicable data/experience sources for modeling CAMDS are considered to be CAMDS testing results and RMA operational data. These data were found to be currently limited in quantity and available only "after the fact" for this analysis. Even though the best available data sources were used in this analysis, it is considered highly desirable that CAMDS testing and RMA operational data be carefully gathered, scrutinized, and then used to modify the results presented herein as applicable in order to provide a higher correlation between characteristics predicted and experienced.

3.0 CAMDS DESCRIPTION

3.1 GENERAL

The CAMDS site is located at the South Area of Tooele Army Depot, Tooele, Utah. All personnel entering the CAMDS facility on foot must go through the Personnel Support Complex (PSC). A 20-foot-wide road provides vehicle access around the perimeter of the CAMDS site. A rail line with a tank car unloading station is located just outside the fenced area. Chemicals are pumped from this unloading station to a bulk chemical storage tank area located inside the fenced area adjacent to the Agent Destruction System (ADS).

All munitions, with the exception of bulk items, will be brought into the fenced area and placed behind a massive barricade identified as the Munition Holding Area (MHA). The munitions stored temporarily in this area are transported to the Unpack Area (UPA) as required for processing.

3.2 DEMIL SYSTEM CONFIGURATIONS

Munition systems to be demilitarized include artillery projectiles with and without explosive bursters, chemical rockets with explosives and propellant, chemical mortars and land mines with explosives, and bombs and spray tanks. Individual subsystems or building blocks are configured to provide for demilitarization of each munition/agent combination listed in Table 3-1. The building blocks and their interrelationship required to demil each munition/agent configuration is presented in Section 4.3. A brief description of major building blocks follows.

3.3 BUILDING BLOCK DESCRIPTION

For the purpose of technical and operational management of the program the CAMDS has been subdivided into a number of building blocks. These building blocks include processing subsystems and system integration functions. The twenty-two which were evaluated in depth include the following:

01 - UPA - Unpack Area
02 - ECC - Explosive Containment Cubicle
04 - DFS - Deactivation Furnace system
05 - MPF - Metal Parts Furnace
06 - RDM - Rocket Demil Machine
08 - UTL - Utilities
09 - EHM - ECC Hydraulics

Table 3-1. Munition Agent Configurations

Munition Type	Agent	Explosive
M55 Rocket	GB,VX	3.2-lb Composition B
M23 Mine	VX	0.8-lb Composition B
105 mm, M360, Burstered	GB	1.1-lb Tetrytol
105 mm, M360, Non-Burstered	GB	None
155 mm, M110 , Burstered	H	0.41-lb Tetrytol
155 mm, M104 , Burstered	HD	0.41-lb Tetrytol
155 mm, M121	GB	None
155 mm, M121A1	GB,VX	None
155 mm, M122	GB	None
8-inch, M426	GB	None
4.2 inch Mortar	HD,HT	0.14-lb Tetryl
MC1 Bomb	GB	None
MK94 Bomb	GB	None
Spray Tank	VX	None
Ton Container	GB,VX	None
Ton Container	HD	None

13 - ADS - Agent Destruction System

14 - ETS - Explosive TReatment System

15 - PDM - Projectile Demil Machine

18 - PPD - Projectile Pull and Drain Machine

19 - CDS - Central Decon System

21 - BIF - Bulk Item Facility

22 - MHE - Material Handling Equipment

23 - FIL - Filter System

24 - MOR - Mortar Demil Machine

25 - MIN - Mine Demil Machine

26 - PIP - Piping

27 - ELE - Electrical

30 - CTV - Closed Circuit Television

31 - COM - Communications

35 - SCS - Site Control System

A brief description of each of the above noted Building Blocks is as follows:

01-UPA-Unpack Area. The purpose of the UPA is to provide an area within the CAMDS where the items to be processed in the ECC and PPD can be reinspected, removed from their shipping and storage containers, and prepared for the demilitarization process. The UPA consists of two areas: the unpack operating area and the airlock area. The housing is physically connected to the ECC housing and faces the Personnel Support Complex (PSC).

02-ECC-Explosive Containment Cubicle. The ECC's primary purpose is to retain the fragments and chemical agents that would result from an explosive incident during demilitarization of chemical munitions. All munitions that contain explosive components will be processed through the ECC to remove the explosive components and cut the explosive into segments small enough to process through the Deactivation Furnace System (DFS). The chemical agent will be drained from rockets and mines in the ECC.

Four separate machines are designed for installation in the ECC, one at a time, dependent on the type of munition to be demilitarized. They are the Rocket Demil Machine (RDM), the Projectile Demil Machine (PDM), the Mortar Demil Machine (MOR) and the Mine Demil Machine (MIN). A conveyor especially designed for each machine connects the unpack area with the machine in the ECC. The ECC discharge conveyor for each machine is located in the ECC housing between the ECC and the DFS.

04-DFS-Deactivation Furnace System. The DFS comprises that area of the CAMDS where propellant and explosives are thermally destroyed. Inert materials (metal and glass) processed along with these explosives and propellants are thermally detoxified of agent.

The major components of the DFS are: an air/blast lock, an oil-fired rotary retort, a shrouded electrically heated discharge conveyor, and an air pollution control system. The air pollution control system is comprised of: a cyclone collector, a slagging afterburner, a variable throat venturi scrubber, a quench tower, a packed bed scrubber, a demister, an air exhaust fan, and a stack.

05-MPF-Metal Parts Furnace. The purpose of the Metal Parts Furnace (MPF) is to thermally destroy residual GB and VX agent contamination on munition components without explosives and to thermally detoxify filled ton containers of H, HD and HT, and munitions without explosives. The MPF system consists of the following major areas: punch chamber, vaporization chamber, burnout chamber, 2 afterburners and APC system.

06-RDM-Rocket Demil Machine. The basic purpose of the RDM is to provide a safe means of remotely separating the bulk of the agent from the M55 rocket and to dissect the rocket into sections small enough to be handled by the DFS. The RDM is installed in the ECC.

08-UTL-Utilities. The UTL will provide for steam, water, septic, compressed air, hydraulic pressure and air-conditioning needs in the CAMDS site.

Process steam is required for the Metal Parts Furnace and Agent Destruction System and the steam will also heat the CAMDS site in the winter. A water distribution system provides for all site needs for fire protection, process and potable water. Compressed air is available to support operations in the UPA, ECC, PDF and BIF. Hydraulic pressure is provided to support equipment in the UPA, ECC, PDF, BIF and ADS.

09-EHM-ECC Hydraulics. The ECC Hydraulic System supplies the hydraulic fluid at the required flow rates and pressure for the ECC, the equipment that is installed in the ECC, and for the ECC input and output conveyors. A similar system is installed in the PDF to supply hydraulic power for the PPD.

13-ADS-Agent Destruction System. The ADS is that area of the CAMDS designed for bulk detoxification of agents GB and VX with only one agent being processed at any time, and will also process plant waste containing GB, VX and mustard.

All agent processing will be performed in "toxic" areas, while the remainder of the ADS housing will contain the brine bulk reduction (drying) and utility units. The processing of chemical agents GB and VX within the ADS is referred to as detoxification and the toxic process module includes all necessary process equipment such as process scrubbers, pumps, heat exchanges, reactors, and agitators as well as "holding" tanks. A bulk reduction area provides for the automatic and continuous processing of the detoxified liquor and contains all equipment necessary to reduce the detoxified liquor to a dry product or sludge which will not produce either a hazard or nuisance from dust, solid fumes, or corrosion.

14-ETS-Explosive Treatment System. The ETS is the area of the CAMDS where sludge and dissolved explosives from spent decontamination solution from the ECC are removed. The filtered spent decon is then pumped to the ADS for final disposal. The ETS is comprised of bag-type filter units, charcoal absorption columns, tanks, pumps, piping, and the necessary controls.

15-PDM-Projectile Demil Machine. All burstered and/or fused projectiles will be processed in the PDM. The machine is installed in the ECC and will receive the munitions via the UPA on ECC Input Conveyor. Once inside the ECC, the PDM will saw the nose closure or fuze from the projectile to expose the burster or supplementary charge for removal by the appropriate removal device. Projectiles that have had their energetic materials removed will undergo further processing in the PPD machine. (See Building Block 18.)

18-PPD-Projectile Pull and Drain Machine. The basic function of the PPD is to remove the nose closure from non-burstered projectiles, pull the burster well, and remove VX and GB agents from projectiles. The PPD is located in the Projectile Disassembly Facility (PDF) and is contained within an interior housing. The PPD includes the following stations: PPD load station, nose closure removal station, burster well weld cutting station, burster well pull station, drain station, and PPD unload station.

19-CDS-Central Decon System. The CDS mixes, stores, and supplies calcium hypochlorite decon solution to all areas of the CAMDS for VX and mustard operations. The CDS also stores sodium hydroxide decon solution prepared in the ADS for supply, on demand, to the PPD, BIF and MPF. The CDS occupies a chamber in the PDF and includes as major components: a decon supply tank, a vacuum conveyor used to transfer hypochlorite powder from shipping drums to the supply tank, two holding tanks, and ancillary control and monitoring equipment.

21-BIF-Bulk Item Facility. The BIF is the area of CAMDS designated for demilitarization of large nerve agent-filled munitions and bulk containers and will process agents GB and VX. The Facility housing incorporates a toxic drain area, agent area, a control room, and an enclosed holding/preparation area. The BIF includes material handling equipment to off-load the bulk items into the holding/preparation area, transport the items into and out of the drain bays, and deliver the items to the input conveyor of the MPF.

22-MHE-Material Handling Equipment. The MHE is utilized in the CAMDS to provide conveyors for the transfer of munitions and munition components to various locations inside the toxic areas. All munitions except bulk items will be processed by the material handling equipment.

23-FIL-Filter System. The filter/ventilation system will assure that exhaust air (minimum of 25 changes per hour) from normally contaminated areas is filtered for agent removal prior to release to the atmosphere. In addition, the system will exhaust (minimum of six changes per hour) from areas where occasional or trace contamination might occur.

24-MOR-Mortar Demil Machine. The purpose of the MOR is to remove the M8 fuse and M14 burster from the 4.2-inch mortar. The mortar machine is located inside the ECC and is remotely operated by the computer control system. The mortar machine will remove the fuse and burster, then will transfer both items by conveyor to the deactivation furnace for destruction. The mortar round will be conveyed to the PPD for further processing.

25-MIN-Mine Demil Machine. The mine machine is designed to remove and separate the M120 booster and the M38 burster, and then drain the agent cavity prior to sending the mine to the Deactivation Furnace (DFS). The M23, VX land mine will be processed in this machine, which is installed in the ECC.

26-PIP-Piping. The CAMDS piping system transfers or routes air, steam, and process liquids within the site. Detectors are installed on the outer double pipe to sense if any agent is leaking during the transport of GB and VX.

27-ELE-Electrical. The primary purpose of the electrical distribution system is to supply and distribute commercial and emergency standby power throughout the CAMDS site. The CAMDS site contains four power transformers: a 75-kva, 208-volt unit for the well pump, a 300-kva, 208-volt unit for the PSC, a 750-kva, 208-volt unit for the CAMDS demil equipment, and a 1500-kva, 480-volt unit also for the CAMDS demil equipment.

The site also has three diesel engine driven emergency standby generator sets to supply power to critical areas in case of a commercial power failure. One 500-kw unit supplies 480-volts and two 235-kw units supply 208 volts.

30-CTV-Closed Circuit Television. These surveillance systems provide for remote observation of machines, conveyors, and maintenance operations in toxic areas.

31-COM-Communications. The CAMDS "COM" system provides direct communication between all control stations and housings on the CAMDS site; e.g., supervisory personnel at control stations can communicate with maintenance personnel wearing level A protective clothing in contaminated areas.

35-SCS-Site Control System. This system exercises master control and monitoring over the CAMDS site.

3.4 DEFINITION OF TERMS

For the purposes of this report in both text and data presentation herein, the following term definitions will apply:

- Accessibility

  A measure of the relative ease of admission to the various areas of an item.

- Availability

  A measure of the degree to which an item is in the operable and committable state at the start of the mission, when the mission is called for at an unknown (random) point in time.

- Building Block

  A functional major subsystem which has a specific purpose in the system and is composed of a number of interfacing modules and components.

- Burn-In

  The operation of an item to stabilize its characteristics.

- Checkout

  Tests or observations of an item to determine its conditions or status.

- Component

  A combination of parts, usually self-contained, which performs a particular function (or more than one function) and is usually at the replaceable item level.

- Debugging

  A process to detect and remedy inadequacies, preferably prior to operational use.

- Demonstrated

  That which has been proven by the use of concrete evidence gathered under specified conditions.

- Failure

  The inability of a part, component assembly, etc., to perform its required function within specified limits.

- Failure Analysis

  The logical, systematic examination of an item to identify and analyze the cause and mode of failure of the item.

- Failure Mode

  The manner in which a hardware item fails.

- Failure Mode Effects Analysis (FMEA)

  A technique for system design evaluation which lists elements of that design, determines the effects of modes on system/elements, and documents built-in deterrence or corrective action necessary.

- Failure, Random

  Any failure whose occurrence is unpredictable in an absolute sense but which is predictable only in a probabilistic or statistical sense.

- Failure Rate

  The number of failures of an item per unit measure of life in cycles, time, or events as applicable.

- Hazard Level

  A qualitative measure of hazards stated in relative terms. The following definitions of hazards levels are in consonance with applicable MIL Specifications.

- Human Engineering

  The area of human factors which applies scientific knowledge to the design of items to achieve effective man-machine integration and utilization.

- Inherent

  Achievable under ideal conditions, generally derived by analysis and potentially present in the design.

- Item

  Used herein to denote the lowest level of hardware assembly as a component or part.

- Maintainability

  A characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.

- Maintenance

  All actions necessary for retaining an item in or restoring it to a specified condition.

- Maintenance, Corrective

  The actions performed, as a result of failure, to restore an item to a specified condition.

- Maintenance, Preventive

  The actions performed in an attempt to retain an item in a specified condition by providing systematic inspection, detection and prevention of incipient failure.

- Mean-Time-Between-Maintenance

  The mean of the distribution of the time intervals between maintenance

- Mean-Time-To-Repair (MTTR)

  The total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time.

- Mean-Maintenance-Time

  The total preventive and corrective maintenance time divided by the total number of preventive and corrective maintenance actions during a specified period of time.

- Mean-Time-Between-Failures (MTBF)

  For a particular interval, the total functioning life of a population of an item divided by the total number of failures within the population during the measurement interval. The definition holds for time, cycles, miles, events, or other measure of life units.

- Mission

  The objective of task which with the purpose clearly indicates the action to be taken.

- Module

  An assembly of components generally at the replacement level.

- Operable

  The state of being able to perform the intended function.

- Operational

  Pertaining to the state of actual usage.

- Predicted

  That which is expected at some future date, postulated on analysis of past experience.

- Redundancy

  The existence of more than one means for accomplishing a given function.

- Redundancy, Active

  That redundancy wherein all redundant items are operating simultaneously rather than being switched on when needed.

- Redundancy, Standby

  That redundancy wherein the alternative means of performing the function is inoperative until needed and is switched on upon failur of the primary means of performing the function.

- <u>Reliability</u>

  The probability that an item subassembly, assembly, or system will perform its intended function for a specified interval under stated conditions.

- <u>Safety</u>

  The conservation of human life and its effectiveness and the prevention of damage to equipments consistent with mission requirements.

- <u>Storage Life (Shelf Life)</u>

  The length of time an item can be stored under specified conditions and still meet specified requirements.

- <u>System</u>

  The functional total of all Building Blocks required to accomplish a process and representable by a process logic diagram.

- <u>Time, Active</u>

  That time during which an item is in the operational inventory.

- <u>Time, Adjustment or Calibration</u>

  That element of Maintenance Time during which the needed adjustments of calibrations are made.

- <u>Time, Administrative</u>

  Those elements of Delay Time that are not included in Supply Delay Time.

- <u>Time, Checkout</u>

  That element of Maintenance Time during which performance of an item is verified to be in specified condition.

- <u>Time, Cleanup</u>

  That element of Maintenance Time during which the item is enclosed and extraneous material not required for operation is removed.

- <u>Time, Delay</u>

  That element of Downtime during which no maintenance is being accomplished on the item because of either supply delay or administrative reasons.

- <u>Time, Down (Downtime)</u>

  That element of Time during which the item is not in condition to perform its intended function.

- Time, Fault Correction

  That element of Maintenance Time during which a failure is corrected by (a) repairing in place; (b) removing, repairing, and replacing; or (c) removing and replacing with a like serviceable item.

- Time, Fault Location

  That element of Maintenance Time during which testing and analysis is performed on an item to isolate a failure.

- Time, Item Obtainment

  That element of Maintenance Time during which the needed item or items are being obtained from designated organizational stockrooms.

- Time, Mission

  That element of Uptime during which the item is performing its designated mission.

- Time, Modification

  The time necessary to introduce any specific change(s) to an item to improve its characteristics or to add new ones.

- Time, Preparation

  That element of Maintenance Time needed to obtain the necessary test equipment and maintenance manuals, and set up the necessary equipment to initiate fault location.

- Time, Reaction

  That element of Uptime needed to initiate a mission, measured from the time the command is received.

- Time, Supply Delay

  That element of Delay Time during which a needed item is being obtained from other than the designated organizational stockrooms.

- Time, Turn-Around

  That element of Maintenance Time needed to service or check out an item for recommitment.

- Time, Up (Uptime)

  That element of Active Time during which an item is either alert, reacting, or performing a mission.

- Uptime Ratio

  The quotient of Uptime divided by Downtime.

- Wearout

  The process of attrition which results in an increase of the failure rate with increasing age (cycles, time, miles, events, etc., as applicable for the item).

3.5 DOCUMENTS REVIEWED

In addition to technical discussions with key engineering and supervisory personnel at both Edgewood Arsenal and Tooele Armu Depot, a relatively large number of drawings, test reports, design criteria, and related U.S. Army documents were reviewed by the contractors in preparation for baselines of this report. The sources of information for the data presented herein are as follows:

MIL-STD-785A	Reliability Program for Systems and Equipment Development and Production
MIL-STD-721B	Definitions of Effectiveness Terma for Reliability, ...
MIL-STD-470	Maintainability Program Requirements
MIL-STD-882	Requirements for Systems Safety Programs
MIL-STD-1472A	Human Engineering Design Criteria for Military Systems ...
MIL-STD-280A	Definitions of Item Levels Exchangeability Models and Related Terms
AMCP-702-3	Reliability Handbook
FARADA	Failure Rate Data Handbook - Navy FMSAEG
RADC-TR-68-14	Nonelectronic Reliability Handbook, RADC, N.Y.
PMO (Aberdeen) 28 May 1975	Chemical Munition Stockpile Inspection Conducted in Support of the Chemical Agent Munition Disposal System (CAMDS)
EA & TEAD (April 1975)	Design Criteria, CAMDS

Hercules, Inc.	Preliminary Hazards Analysis of a Metal Parts Furnace and Air Pollution Control System
Hercules, Inc.	Failure Mode and Hazardous Effects Analysis of a Metal Parts Furnace and Air Pollution Control System
PMO (TEAD) (Maj. Timpf)	Enclosure 17, Surveillance and Movement of Munitions, to Draft Demilitarization Plan, July 1975
The Marquardt Co.	Engineering Evaluation of the CAMDS Munitions Demil Machinery Design, 01, Vol I, 1974
The Marquardt Co.	Engineering Evaluation of the CAMDS Munitions Demil Machinery Design, 01, Vol II, 1974
PMO - TEAD (28 May 1975)	Chemical Munition Stockpile Inspection - Support of CAMDS
TEAD	Enclosure 5, Explosive Containment Cubicle Testing and Related Data, to Draft Demil Plan for CAMDS, July 1975
TEAD	CAMDS Test Reports - various series, 1972-75
TEAD	CAMDS Drawings - Aperture Cards, as available
Hercules Inc.	Preliminary Hazards Analysis of a Deactivation Furnace and Air Pollution Control System
Hercules, Inc.	Failure Mode and Hazardous Effect Analysis of Deactivation Furnace and Air Pollution Control System
Hercules, Inc.	Failure Mode and Hazardous Effect Analysis of the Agent Destruction System for CAMDS.

Additional References include the following:

(1) MIL-HDBK-472, 24 May 1966, "Military Standardization Handbook, Maintainability Prediction".

(2) Army regulation number 702-3, 22 March 1973 (Revision pages October 1973). "Product Assurance, Army Material Reliability, Availability, and Maintainability (RAM)".

(3) MIL-HDBK-217A, 1 December 1965, "Military Standardization Handbook, Reliability Stress and Failure Rate Data for Electronic Equipment".

(4) RADC-TDR-64-373, Vol. I Final Report, "Analysis of Maintenanc Task Time Data (covering electrical, electronic and electro-mechanical components during Weapon System Operation Phase)," December 1964. Reliability Branch, Rome Air Development Center, Research and Technology Division, Air Force Systems Command, Griffiss Air Force Base, New York.

(5) RADC-TDR-64-373, Vol. II Final Report, "Analysis of Maintenance Task Time Data (covering mechanical components during Weapon System Operational Phase)," December 1964. Reliability Branch, Rome Air Development Center, Research and Technology Division, Air Force Systems Command, Griffiss Air Force Base, New York.

(6) AMRL-TR-68-74, "A Portable Test Battery for Comparatively Evaluating Operator Performance in Full-Pressure Suit Assemblies," October 1968. Aerospace Medical Research Laboratories, Aerospace Medical Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.

(7) Huchingson, R. D. "An Evaluation of the Gemini 3C-8 and the USN Mark IV Pressure Suits to Determine their Effects on Seven Psychomotor Skills." Dallas, Texas; LTV Aerospace Corporation, Undated.

(8) Walk, D. E., "Finger Dexterity of the Pressure-Suited Subject." Wright-Patterson AFB, Ohio: Aerospace Medical Research Labor tories, AMRL-TDR-64, 1964.

(9) AMRL-TR-66-235, "Evaluation of Manned Orbiting Laboratory Design Definition Pressure Garments," July 1968. Aerospace Medical Research Laboratories, Aerospace Medical Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.

(10) MIL-STD-756A, 15 May 1963, "Military Standard, Reliability Prediction."

(11) Bazovsky, Igor "Reliability Theory and Practice," Pretice-Hall Inc., 1962.

(12) TRW Report No. 95436-002 (Prepared under Contract No. DAAG-49-75-C-0135), 2 October 1975, "Safety Analyses and Hazard Evaluation Report, Failure Modes and Effects Analysis for CAMDS."

(13) RADC-TR-74-268, Final Report, October 1974, "Revision of RADC Nonelectronics Reliability Notebook" (RADC-TR-69-458, Section 2), Martin Marietta Aerospace Corporation, Rome Air Development Center, Air Force Systems Command, Griffiss Air Force Base, New York 13441.

4.0 PHASE I SYSTEMS LEVEL ANALYSIS

4.1 ANALYSIS APPROACH AND METHODOLOGY

To estimate the production rates for each CAMDS configuration the analysis is performed in the following logic sequence.

1) Determine the system availability resulting from random failures and time to repair them.

2) Determine the reduction in system availability as a result of other factors such as environmental conditions and utilities.

3) Determine the production levels for each operational condition (scenario) based on equipment capacity(s) and estimated system availability.

4) Determine the reduction to estimated production levels as a function of operational and preventive maintenance requirements.

Estimates of the failure rates and maintenance times for each configuration were obtained by summing the failure rates and maintenance times for each individual building block. This assumes that all production critical building blocks operate in series, and a failure of any one building block will cause the total system to become inoperable. This method provides reasonable (slightly conservative) estimates of system availability.

Given the failure rates ($N\lambda$) and maintenance times ($N\lambda TM$) of each building block, the mean time between failure (MTBF) and mean time to repair (MTTR) for the system are determined as

$$MTBF = \Sigma \frac{1}{N\lambda} \quad \text{and} \quad MTTR = \Sigma \frac{N\lambda TM}{N\lambda} \Big/ \Sigma N\lambda$$

The availability of the system considering the occurrance of random failures is then

$$\text{Availability} = \frac{1}{1 + \frac{MTTR}{MTBF}}$$

In addition to the availability of the system as represented by the individual building blocks, the system production levels are also influenced by other factors such as weather and utilities. These factors can be incorporated into one term representing a modification factor to the total system availability. Again assuming each factor influencing the operation of the system is in series, this external modification factor can be multiplied by the availability of the system as influenced by random failures. Because it may be necessary to schedule operational maintenance on the facility during the normal operational period, the production levels resulting from both internal and external failures must be modified to include the effects from these scheduled down times. The total availability of the system will then be:

$$\text{Availability} = \text{Availability}_R * \text{Availability}_{EX}$$

where

Availability_R is the availability of the system when accounting for internal random failures

Availability_{EX} is the availability of the system when accounting for external random failures

T_m is schedule operational maintenance times

T is normal operating period.

Daily production of the system is determined by finding the daily time period (Top) when the system is operating normally.

$$\text{Top} = \text{Availability} * T$$

and factoring this by the maximum system production rate.

$$\text{Daily production} = \text{Top} * (\text{production rate})$$

4.2 FACTORS INFLUENCING PRODUCTION RATES

System production rates can be influenced by a number of equipment, operational, and other factors. Equipment factors include the production capacity of the building block equipment and production time lost due to operational maintenance requirements, preventive maintenance requirements, and equipment failures. Operational factors include production scheduling, operator proficiency, and those safety and environmental requirements that result in production time reducing procedures. Other factors which influence production include environmental conditions such as wind, snow, and extreme temperature; the availability of utility services, power outages, for example; the availability of consumables such as fuel, caustic soda, etc.; and the availability of repair parts.

4.2.1 Equipment Factors

4.2.1.1 Equipment Capacity

Capacities of all building blocks in each munition configuration have been assessed and maximum system rates estimated. Table 4-1 summarizes the maximum hourly production rates for each system or munition configuration. The "bottleneck" building block for each configuration is identified in Section 6, however, the demil machines normally pace production. The rates in Table 4-1 are the maximum attainable, without failures or scheduled downtime, based on present building block design status.

4.2.1.2 Operational Maintenance

Production rates can be influenced by the amount of required maintenance which cannot be performed while the system is in operation and cannot wait for preventive maintenance periods. A few of these operational maintenance actions have been identified and are listed in Table 4-2. In a three shift/day operation, downtime will be required to perform this type maintenance.

Table 4-1. Maximum System Production Rates

Munition	Rate (Items/Hour)
M55 Rocket	16
105 mm Projectiles Without Bursters	30
105 mm Projectiles With Bursters	28
155 mm Projectiles Without Bursters	30
155 mm Projectiles With Bursters	28
8" Projectiles	20
4.2" Mortar	50
M23 Land Mine	40
MC-1 Bomb	1.2
Spray Tank	0.2
Ton Containers	0.25

Table 4-2. Identified Operational Maintenance Requirements

Munition	Building Block	Action
M55 Rocket	RDM	Replace saw blades segregator clean-off
Projectiles/Cartridges with Bursters	PDM	Replace saw blades at projectile saw station and burster saw station chip removal
Projectiles/Cartridges without Bursters	PPD	Cutting tool replacement at burster weld cutting station

4.2.1.3 Preventive Maintenance

There are no preventive maintenance actions identified which require system shutdown that cannot be handled adequately during a weekend maintenance shift.

4.2.1.4 Equipment Failures and Repair Times

Data has been developed for expected failures per million hours ($N\lambda$), the mean time between failures (MTBF), the time to repair failures per million hours ($N\lambda TM$), and the mean time to repair (MTTR) for all munition configurations. These data have been developed in the phase II study (Section 5.0), assume that equipment failures are occurring in the random portion of the probability curve, i.e. after system infant failures but before system wearout. The repair times take into account trouble shooting time, agility reductions due to protective suits and gloves, and space/accessibility limitations.

4.2.2 Operational Factors

The production schedule used for this study is a 3 shift/24 hour day - 5 day week with weekends used for preventive maintenance and scheduled overhauls. All production rate estimates assume compliance with all safety requirements imposed and a trained, competent crew of operators and maintenance personnel.

4.2.3 Other Factors

This analysis has assumed that consumables and appropriate repair parts will always be available. The effect of unacceptable environmental conditions and utility service has been described by estimating the number of days per year unacceptable weather conditions would occur and the duration of these conditions and by estimating the number and duration of utility failures. Because of the uncertainty inherent in estimating these conditions, a combined "range" value (0.999) representing "best" and (0.95) "worst" case was selected. This range says that these factors will influence production at worst 5% of the time and at best 0.1% of the time.

4.3 ANALYSIS RESULTS

4.3.1 M55 Rocket

The configuration for the demil of M55 (GB or VX) 115 mm rockets is shown in Figure 4-1. The production bottleneck for the system is the Rocket Demil Machine (RDM). All other subsystems are capable of production rates far in excess of the RDM capacity. At present the RDM rate is running from 3 min 35 sec to 3 min 45 sec per rocket. Therefore the RDM has a production capacity of 16 rockets/hour.

Two frequent operational maintenance actions have been identified that would require shutdown of the system to perform. They are saw blade change in the RDM and segregator clean-off. Saw blade change will take 30-35 minutes and may be required for some stations approximately every 110 rounds. Segregator clean-off should only take 5-10 minutes and will probably be required once per shift.

There have been no preventive maintenance actions identified that require system shutdown that cannot be handled adequately during a weekend maintenance shift.

Equipment failure and repair time data are presented in Tables 4-3 and 4-4. As indicated, the availability of internal systems are .8439 for VX and .8535 for GB. As stated previously, because of the uncertainty in the external factors affecting system operation, a range of availability for "worst" and "best" case conditions for the total system is assumed. This range is presented in Table 4-5 along with the resulting production rates. Any down time for operational and/or preventive maintenance will reduce production rates as shown in Figures 4-2 and 4-3. The production rate for a 30 minute downtime per operating shift (total 90 minute down time) for saw blade replacement is also indicated in the figures.

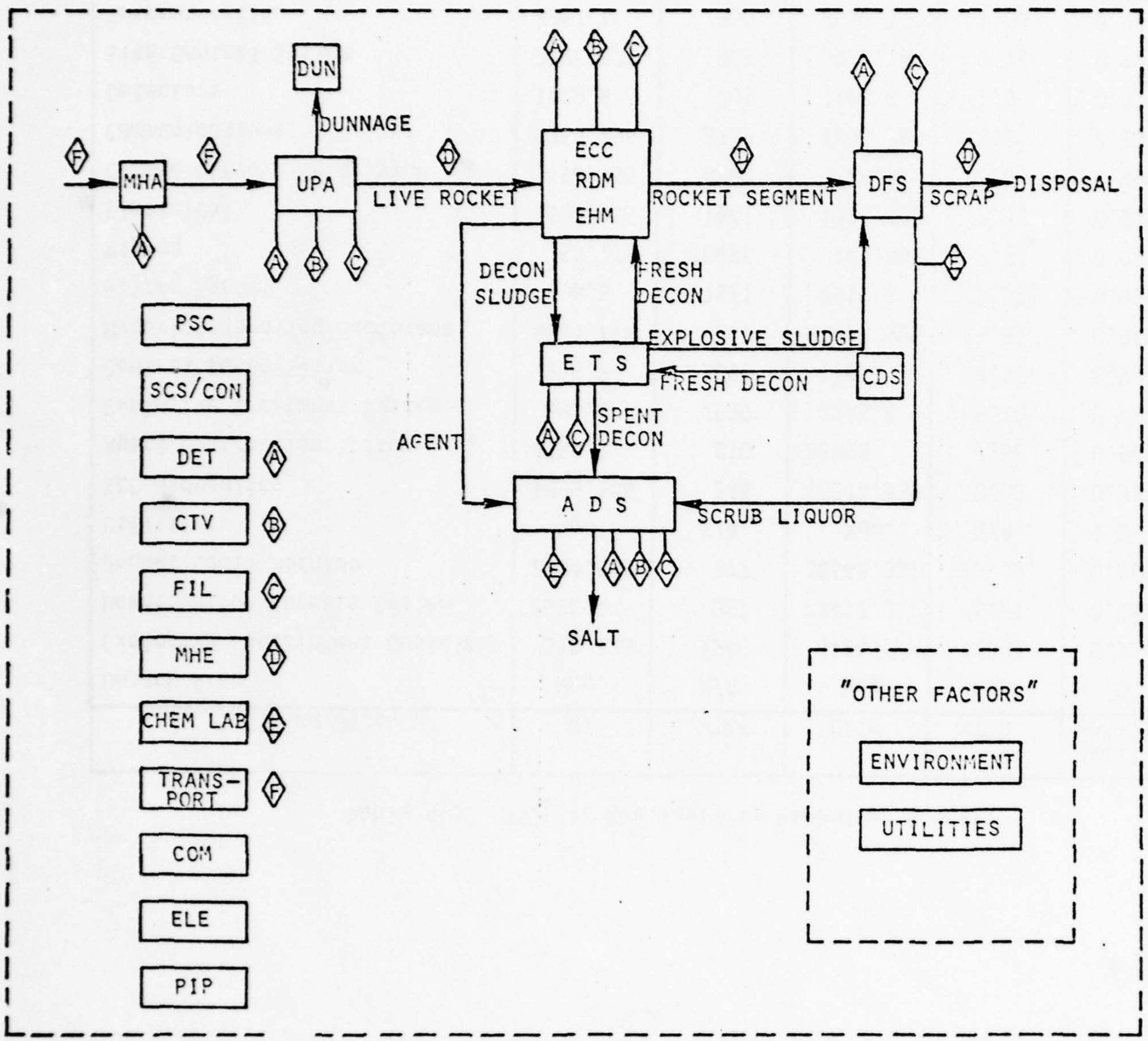

Figure 4-1. Munition Demil System, M55 Rockets, GB/VX

Table 4-3. M55(VX) Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Avail-ability
Unpack Area	Neg.	N/A	Neg.	N/A	~1.0
Explosive Containment Cubicle	510.128	1960	6125.587	12.01	0.9939
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Rocket Demil Machine	2654.534	377	32662.332	12.30	0.9684
Utilities	Neg.	N/A	Neg.	N/A	~1.0
ECC Hydraulics	1836.106	545	18514.839	10.08	0.9818
Agent Destruction System	4769.1	210	35993	7.55	0.9653
Explosive Treatment System	393.9	2539	2246.8	5.70	0.9978
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	4601.758	217	53437.995	11.61	0.9493
Filter System	636.5	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	229.31	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2782.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	26287.5	38.0	184844.3	7.03	.8439

Table 4-4. M55(GB) Availability Parameter Summary

Building Block	Nλ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	Neg.	N/A	Neg.	N/A	~1.0
Explosive Containment Cubicle	510.128	1960	6125.587	12.01	0.9939
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Rocket Demil Machine	2654.534	377	32662.332	12.30	0.9684
ECC Hydraulics	1836.106	545	18514.839	10.08	0.9818
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Explosive Treatment System	393.0	2539	2246.8	5.70	0.9978
Material Handling Equipment	4601.758	217	53437.995	11.61	0.9493
Filter System	636.5	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	.9972
Total Munition Process	24663.9	40.5	171448.0	6.95	.8535

Table 4-5. M55 Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
VX	.8439	.95 - .999	.802 - .8430	307 - 323	400
GB	.8540	.95 - .999	.8113 - .8531	311 - 327	400

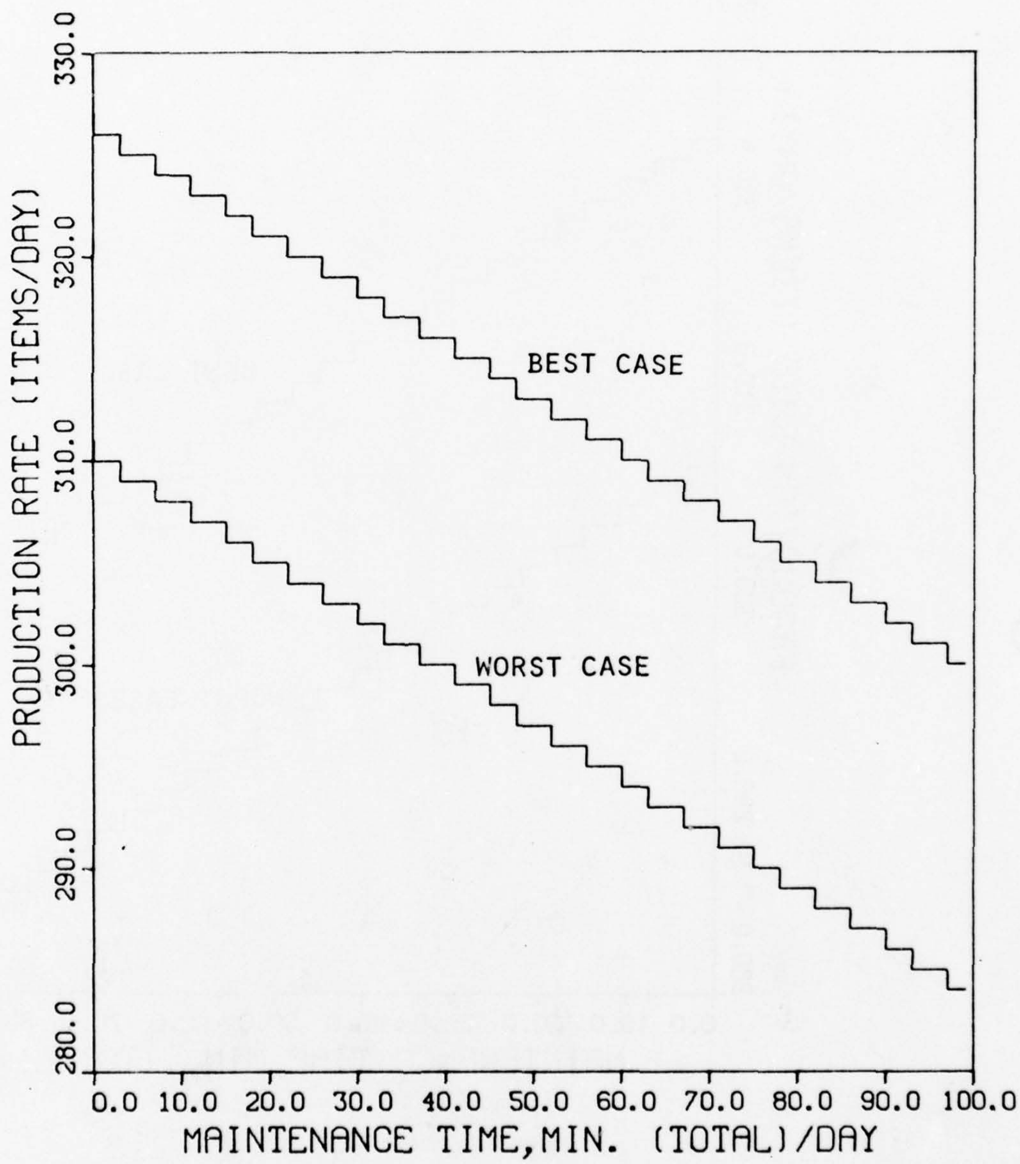

Figure 4-2. Relation Between Production Rate and Maintenance Time, M55, GI

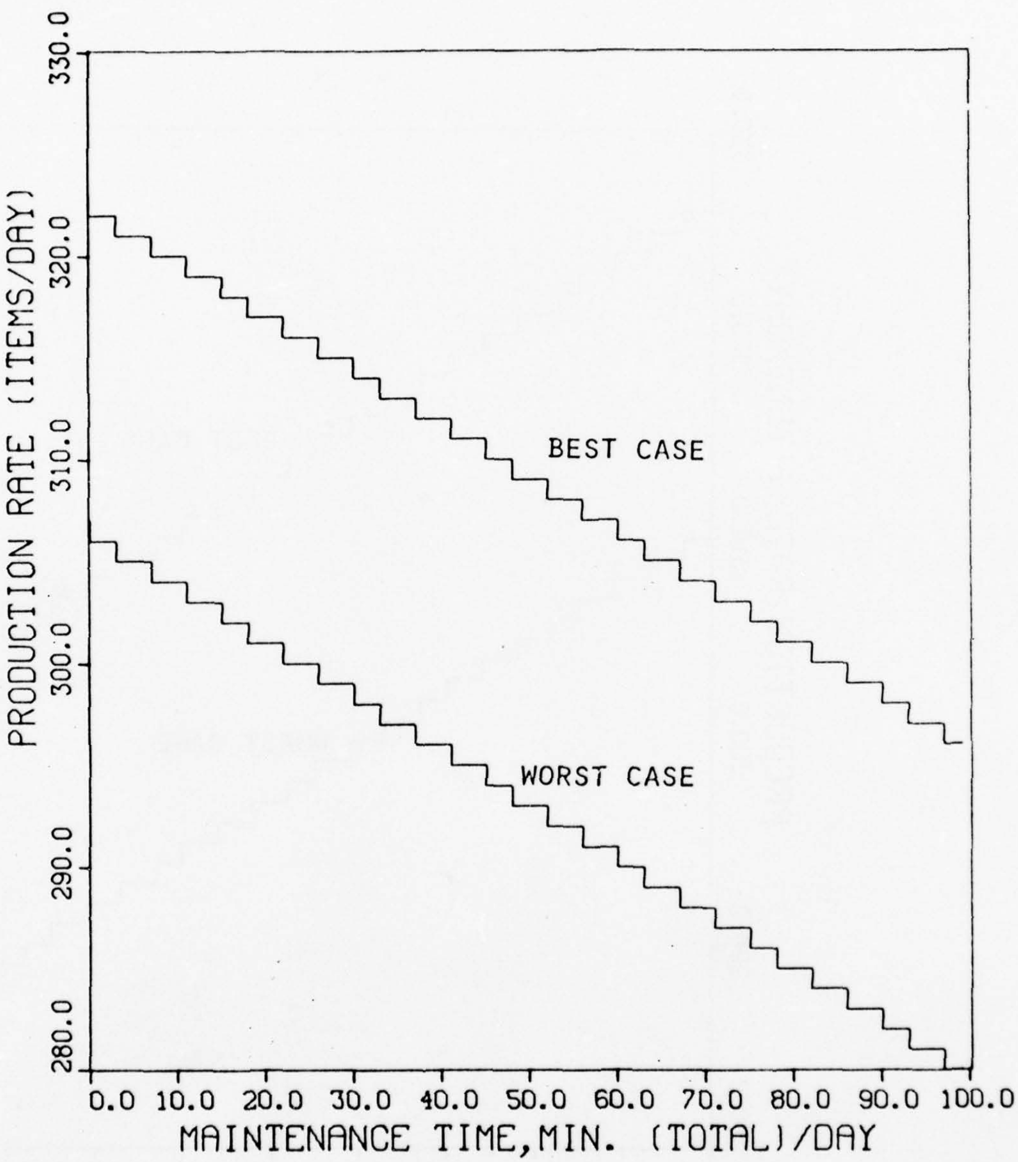

Figure 4-3. Relation Between Production Rate and Maintenance Time, M55, VX

4.3.2 Projectiles/Cartridges, GB or VX Without Bursters

The system for the demil of non-burstered GB or VX filled projectiles ar cartridges is shown schematically in Figure 4-4. All building blocks shown must function to sustain production. However, momentary shutdown of certain elements of the system for preventive, corrective or housekeeping maintenance can be accommodated without affecting production. Examples of elements which can be momentarily shut down are the DUN, the UPA (because of the accumulatic capacity of the PDF input conveyor) and the ADS (agent storage tanks permits continued operation of the rest of the system).

Evaluation of the processing capabilities of the building blocks identif the PPD as the production limiting subsystem. Projected hourly production rates of the PPD are:

105 mm Cartridges	30
155 mm Projectiles	30
8 inch Projectiles	20

No operational or preventive maintenance actions have been identified wh would require shutdown of the production line. As indicated above, certain elements may be momentarily shut down without affecting production. However, all normal maintenance actions can be adequately accomplished during the scheduled weekend shutdowns and no requirement for partial shutdown of the li can be identified.

Equipment failure and repair time data for each of the projectile/cartri without bursters configurations are presented in Tables 4-6 to 4-13. The ran of availability including external factors and the resulting production rates given in Table 4-14. These rates do not include maintenance times which redu production. Any down time for maintenance will reduce the production rates a indicated in Figures 4-5 to 4-10

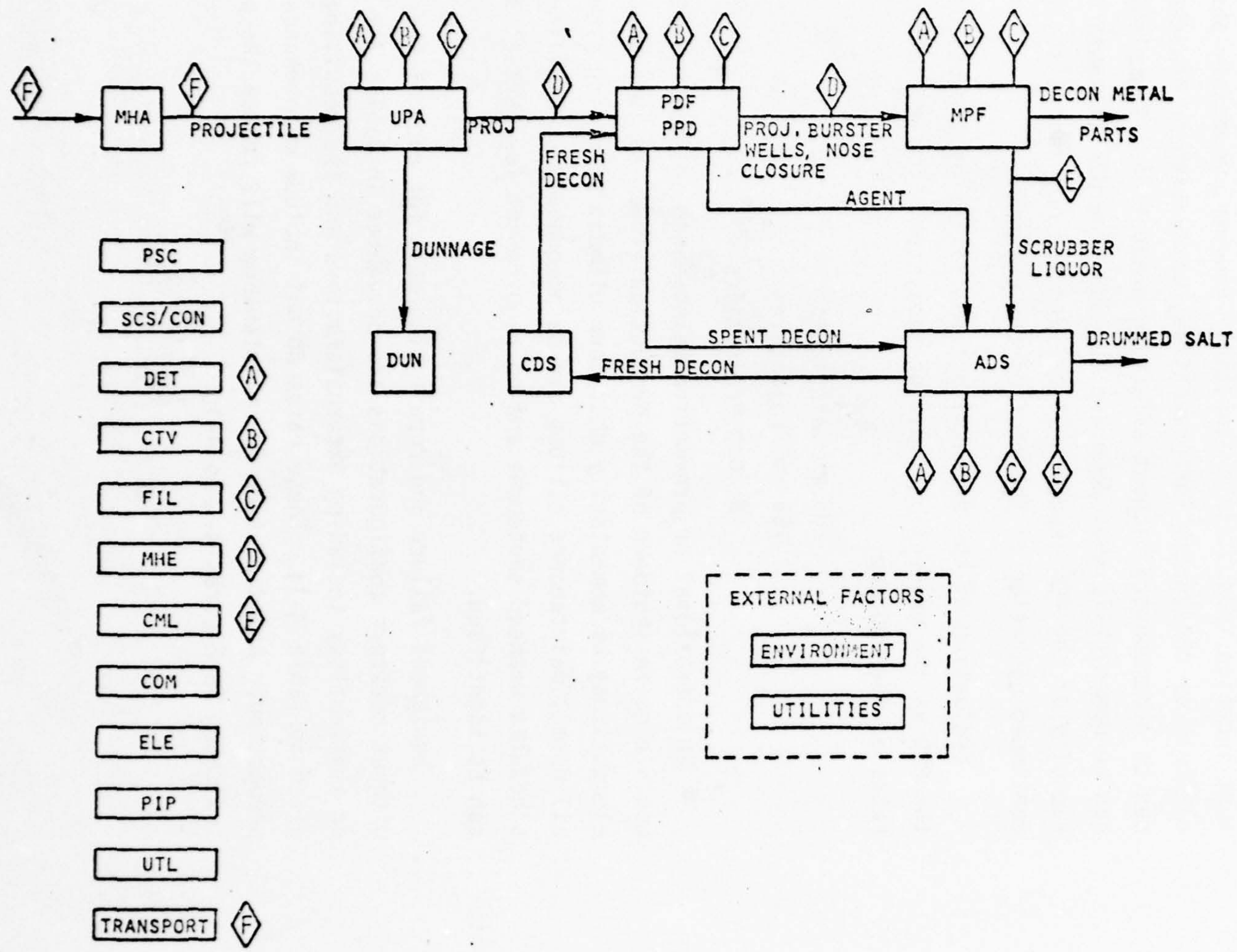

FIGURE 4-4. MUNITION DEMIL SYSTEM - GB/VX WITHOUT BURSTERS, CARTRIDGES/PROJECTILES

Table 4-6. Cartridge, 105mm, M360, GB Without Bursters Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Unpack Area	Neg.	N/A	Neg.	N/A	≈ 1.0
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	4328.878	231	43193.280	9.98	0.9586
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projection Pull and Drain Machine	5133.993	195	53120.012	10.35	0.9496
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1920.052	521	17048.666	8.88	0.9832
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700.	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	28167.2	35.5	193970.3	6.89	.8375

Table 4-7 Cartridge, 105 mm, M360, GB, Without Bursters, With Welded Burster Well Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Avail-ability
Unpack Area	Neg.	N/A	Neg.	N/A	≈ 1.0
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	4328.878	231	43193.280	9.98	0.9586
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	5693.613	176	57945.615	10.18	0.9452
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1920.052	521	17048.666	8.88	0.9832
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	3760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	28726.9	34.8	198795.9	6.92	.8341

Table 4-8 Projectile, 155 mm, M121A1, GB, Without Bursters Availability Parameter Summary

Building Block	Nλ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.2	0.9720
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	3539.685	283	36571.318	10.33	0.9647
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1386.589	721	11925.633	8.60	0.9882
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	24826.4	40.3	158487.7	6.4	0.8632

Table 4-9 Projectile, 155, M121A1, VX, Without Bursters
Availability Parameter Summary

Building Block	Nλ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2374.761	348	28797.522	10.02	0.9720
Agent Destruction System	4769.1	210	35993	7.55	0.9653
Projectile Pull and Drain Machine	3539.685	283	36571.318	10.33	0.9647
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1386.589	721	11925.633	8.60	0.9882
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.4	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	*26198.3*	*38.2*	*170714.8*	*6.5*	0.8542

Table 4-10 Projectile, 155 mm, M122, GB, Without Bursters
Availability Parameter Summary

Building Block	Nλ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Metal Parts Furnace	4380.3	328	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.02	0.9720
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	3539.685	283	36571.318	10.33	0.9647
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1386.589	721	11925.633	8.60	0.9882
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	24826.4	40.3	158487.7	6.4	0.8632

Table 4-11 Projectile, 155mm, M121, GB, Without Bursters Availability Parameter Summary

Building Block	Nλ	MTBF	NλTM	MTTR	Availability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.02	0.9720
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	3539.685	283	36571.318	10.33	0.9647
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling	1386.589	721	11925.633	8.60	0.9882
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	24826.4	[illegible].3	158487.7	6.4	0.8632

Table 4-12 Projectile, 155 mm, M121, GB, Without Bursters, With Welded Burster Well Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.02	0.9720
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	3903.438	256	39707.961	10.71	0.9618
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1386.589	721	11925.633	8.60	0.9882
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	25190.1	39.7	161624.3	6.4	0.8609

Table 4-13 Projectile, 8", M426, GB, Without Bursters Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Unpack Area	153.506	6514	371.708	2.42	0.9996
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	1836.106	545	18514.839	10.08	0.9818
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Projectile Pull and Drain Machine	2400.892	417	24750.822	10.31	0.9758
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	1005.544	994	8766.324	8.22	0.9918
Filter System	636.4	1571	4512.6	7.09	0.9955
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	22180.4	45.1	132512.0	6.0	0.8830

Table 4-14. Projectiles/Cartridges, GB or VX Without Bursters Availability and Production Rate Summary

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
105 mm, M360, GB	.8375	.95 - .999	.7956 - .8367	572 - 602	1000
105 mm, M360, GB With welded burster well	.8341	.95 - .999	.7923 - .8333	570 - 600	1000
155 mm, M121A1, GB	.8632	.95 - .999	.8200 - .8623	590 - 620	650
155 mm, M121A1, VX	.8542	.95 - .999	.8115 - .8533	584 - 614	650
155 mm, M122, GB	.8632	.95 - .999	.8200 - .8623	590 - 620	650
155 mm, M121, GB	.8632	.95 - .999	.8200 - .8623	590 - 620	650
155 mm, M121, GB With welded burster well	.8609	.95 - .999	.8179 - .8600	588 - 619	650
8", M426, GB	.8830	.95 - .999	.8389 - .8821	402 - 423	400

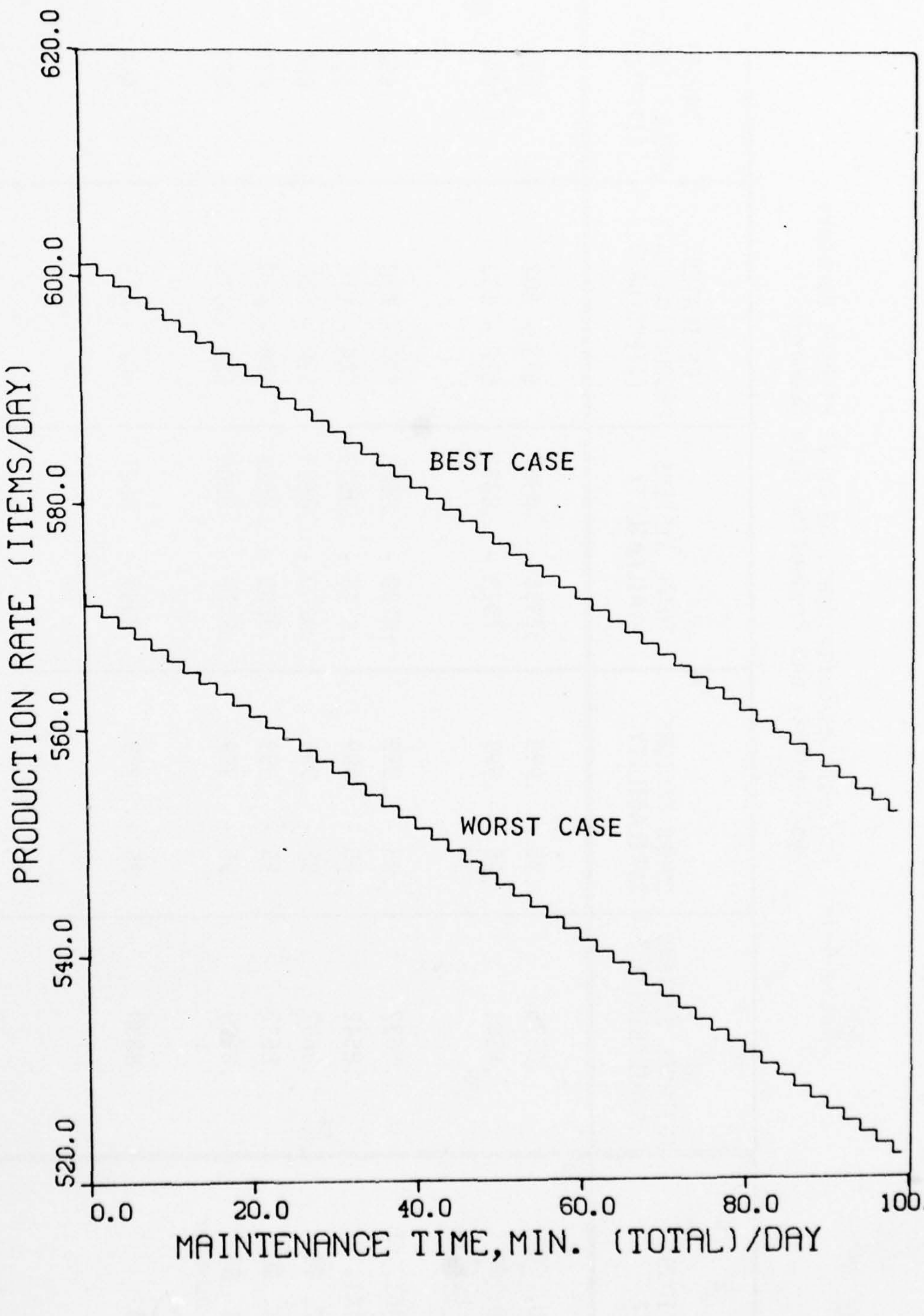

Figure 4-5 Relation Between Production Rate and Maintenance Time, Cartridge, 105 mm, M360, GB, Without Bursters

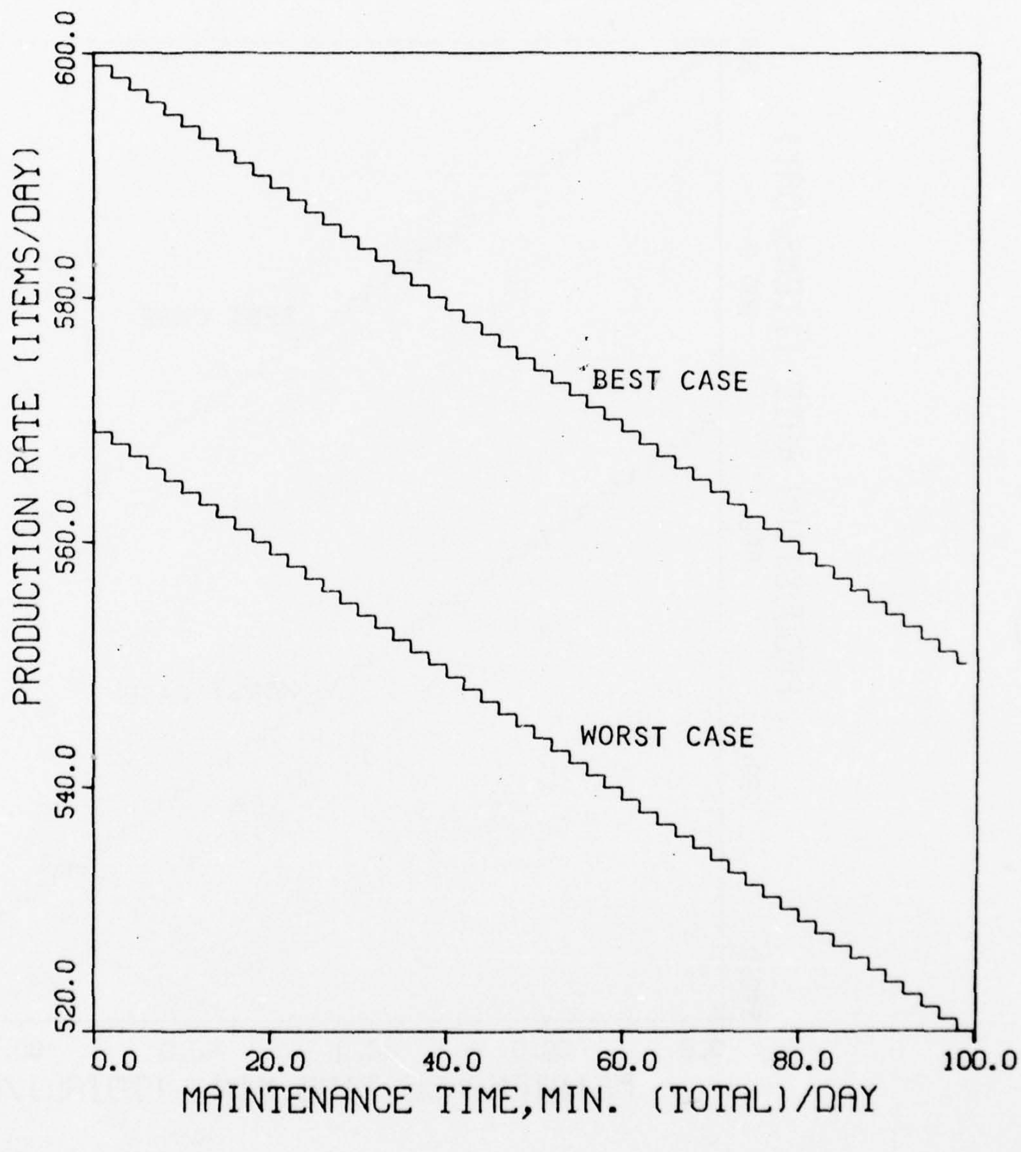

Figure 4-6. Relation Between Production Rate and Maintenance Time, Cartridge, 105 mm, M360, GB Without Bursters, With Welded Burster Well.

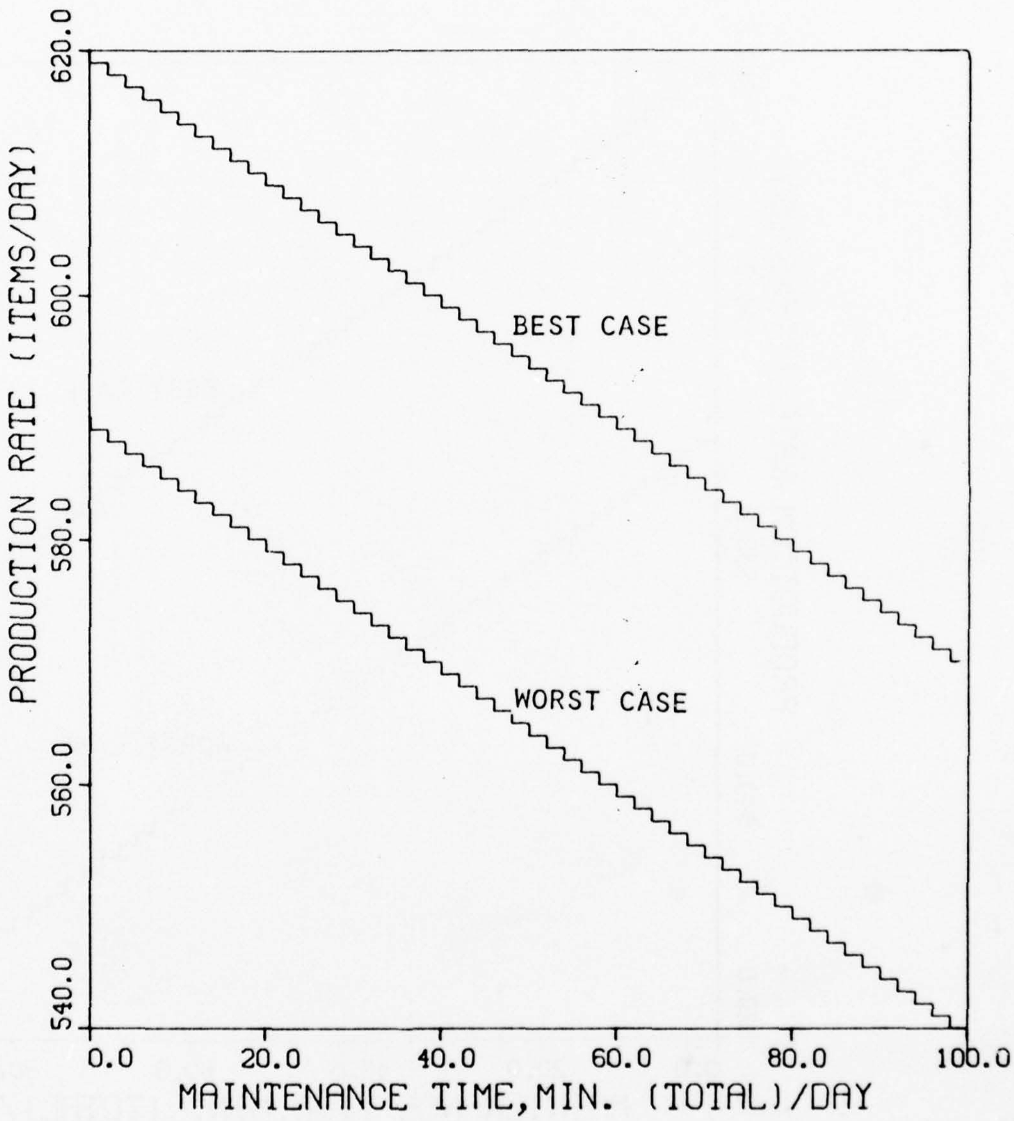

Figure 4-7 Relation Between Production Rate and Maintenance Time, Projectile, 155 mm, M121A1, GB, Without Bursters and Projectile, 155 mm, M122, GB, Without Bursters Projectile, 155 mm, M121, GB, Without Bursters

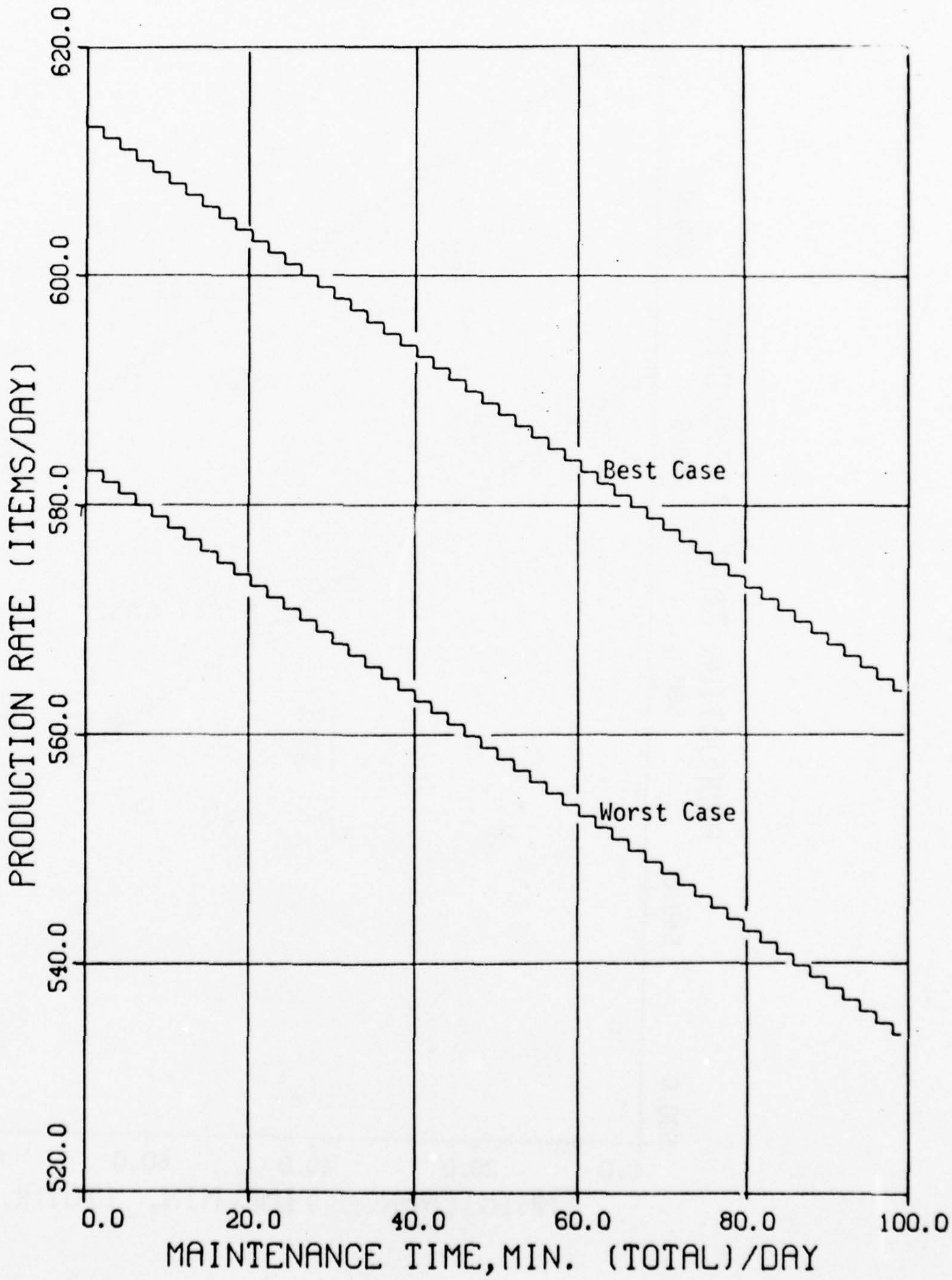

Figure 4-8. Relation Between Production Rate and Maintenance Time, Projectile, 155 mm, M121A1, VX, Without Bursters.

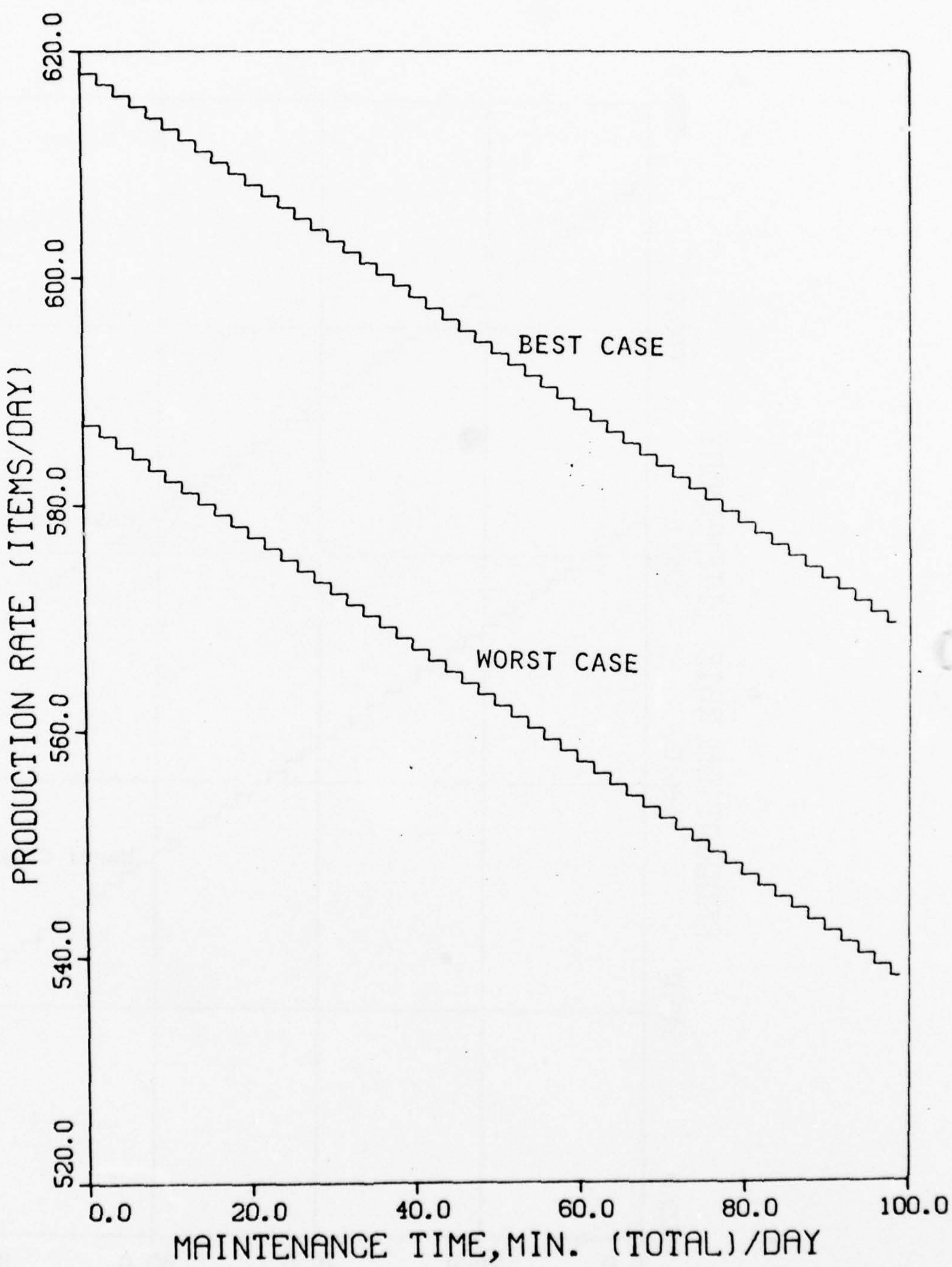

Figure 4-9 Relation Between Production Rate and Maintenance Time, Projectile, 155 mm, M121, GB, Without Bursters, With Welded Burster Well.

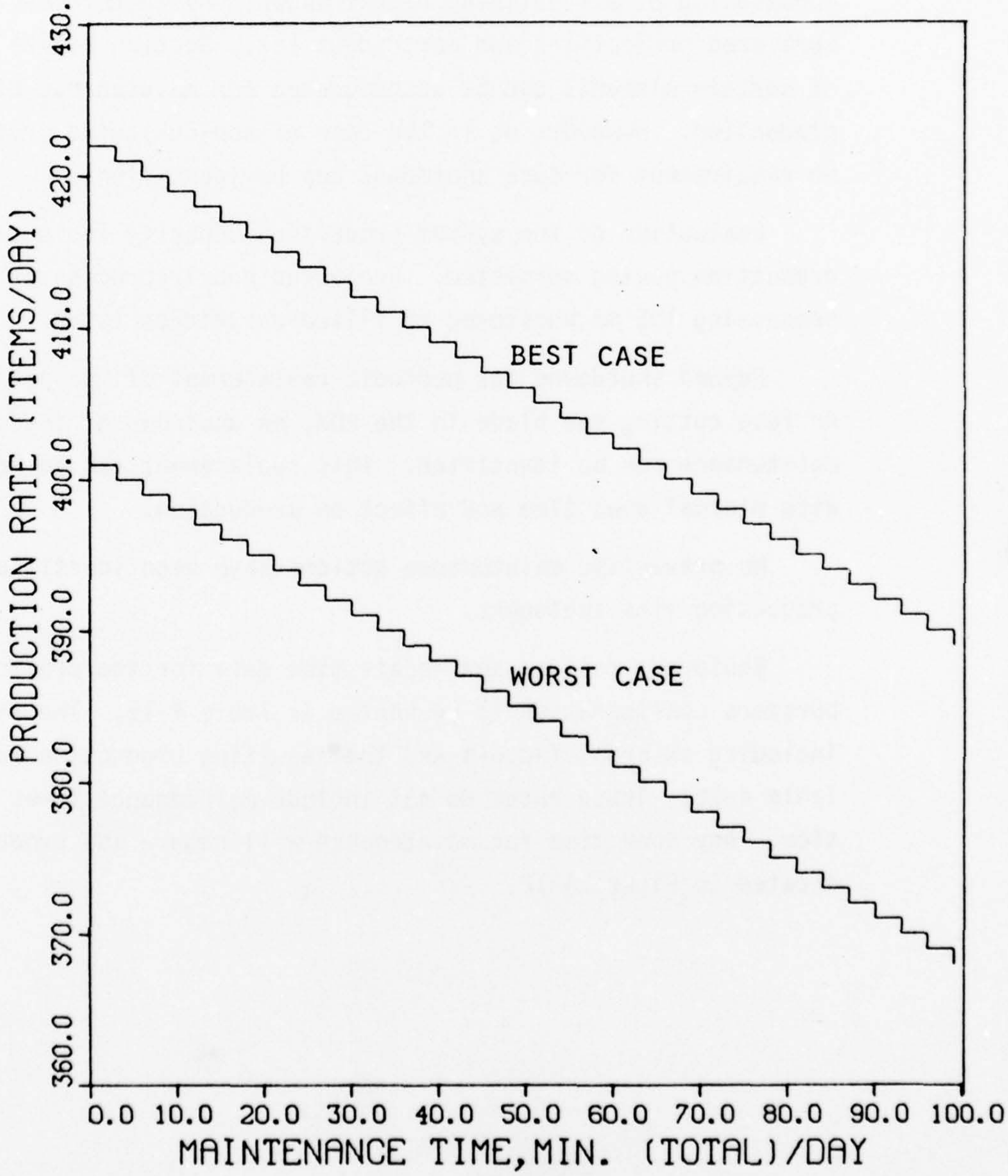

Figure 4-10. Relation Between Production Rate and Maintenance Time, Projectile, 8", M426, GB, Without Bursters

4.3.3 Cartridge, GB With Bursters

The system for the demil of burstered GB filled projectiles and cartridge is shown schematically in Figure 4-11. Sustained production requires the functioning of all building blocks shown. As in the case for GB/VX filled nor burstered projectiles and cartridges (cf., Section 4.3.2) momentary shutdown of certain elements can be accommodated for maintenance without disrupting production. However, as in the case of non-burstered projectiles/cartridges, no requirement for such shutdowns can be identified.

Evaluation of the system production capacity indicates the PDM as the production pacing subsystem. Projected hourly processing rates of the PDM processing 105 mm burstered GB filled cartridges is 28.

Beyond shutdowns for periodic replacement of the projectile nose closure or fuse cutting saw blade in the PDM, no shutdown of the system for operationa maintenance can be identified. This replacement can be readily accomplished with minimal down time and effect on production.

No preventive maintenance actions have been identified which would requir production line shutdown.

Equipment failure and repair time data for the projectile/cartridges with bursters configuration is presented in Table 4-15. The range of availability including external factors and the resulting production rates are given in Table 4-16. These rates do not include maintenance times which reduce production. Any down time for maintenance will reduce the production rates as indicated in Figure 4-12.

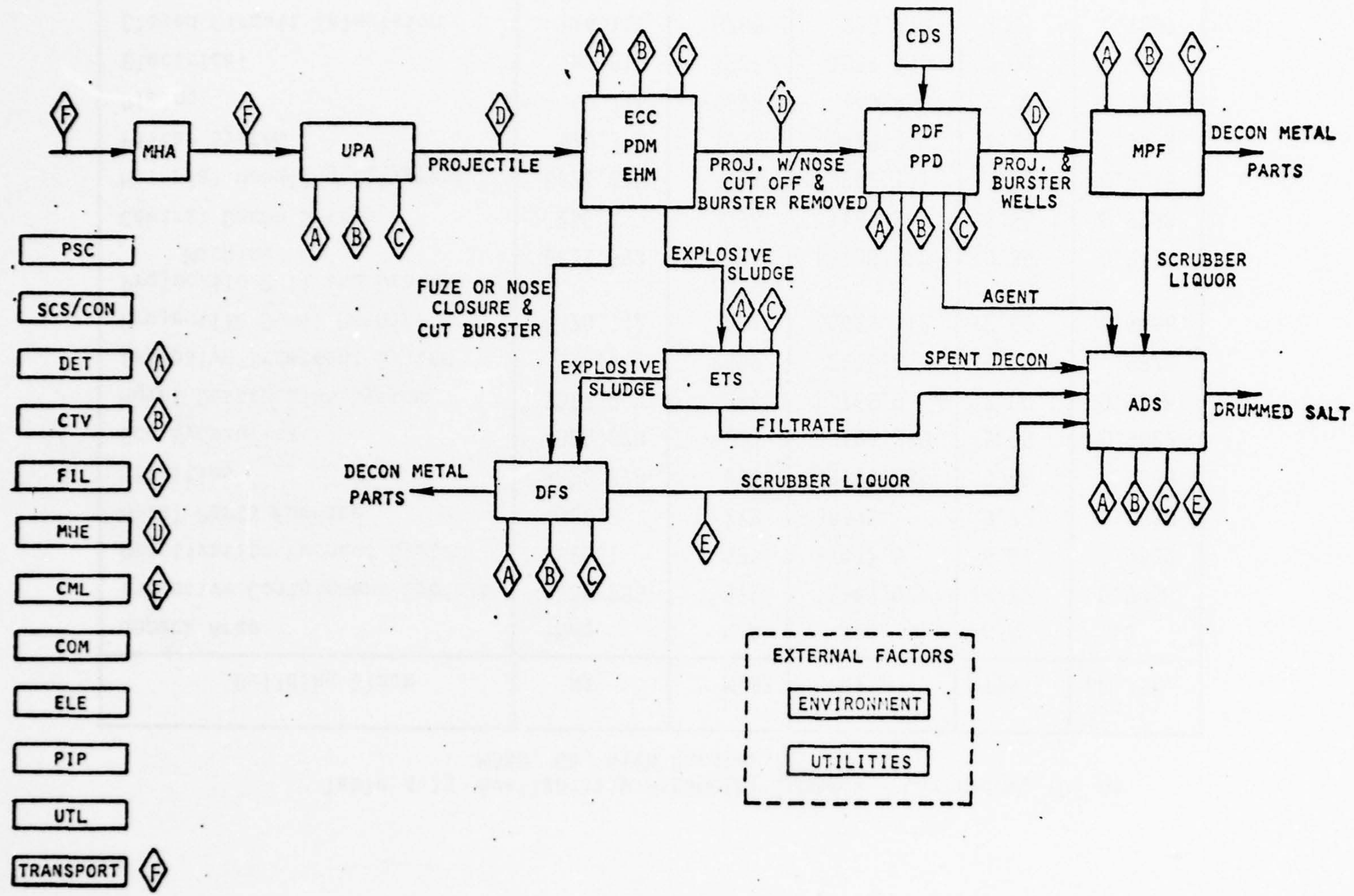

FIGURE 4-11 MUNITION DEMIL SYSTEM - GB/VX WITH BURSTERS, PROJECTILES/CARTRIDGES

Table 4-15 Availability Parameter Summary - Cartridge, 105 mm M360, GB, With Bursters

Building Black	Nλ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	Neg.	N/A	Neg.	N/A	1.0
Explosive Containment Cubicle	1138.286	879	13344.927	11.72	0.9868
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	4328.878	231	43193.280	9.98	0.9586
Ecc Hydraulics	4328.878	231	43193.280	9.98	0.9586
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Explosive Treatment System	393.9	2539	2246.8	5.70	0.9978
Projectile Demil Machine	4470.142	224	56525.312	12.65	0.9465
Projectile Pull and Drain Machine	5133.993	195	53120.012	10.35	0.9496
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Material Handling Equipment	5426.815	184	43942.101	8.10	0.9579
Filter System	970.3	1031	6879.4	7.09	0.9932
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1085.888	3.0	0.9989
Detectors	1428.6	700.	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.00	0.9972
Total Munition Process	44859.2	22.3	35598.1	7.9	.7384

Table 4-16 Cartridge, GB, With Bursters Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
105 mm, M360, GB	.7384	.95 - .999	.7015 - .7377	471 - 495	1000

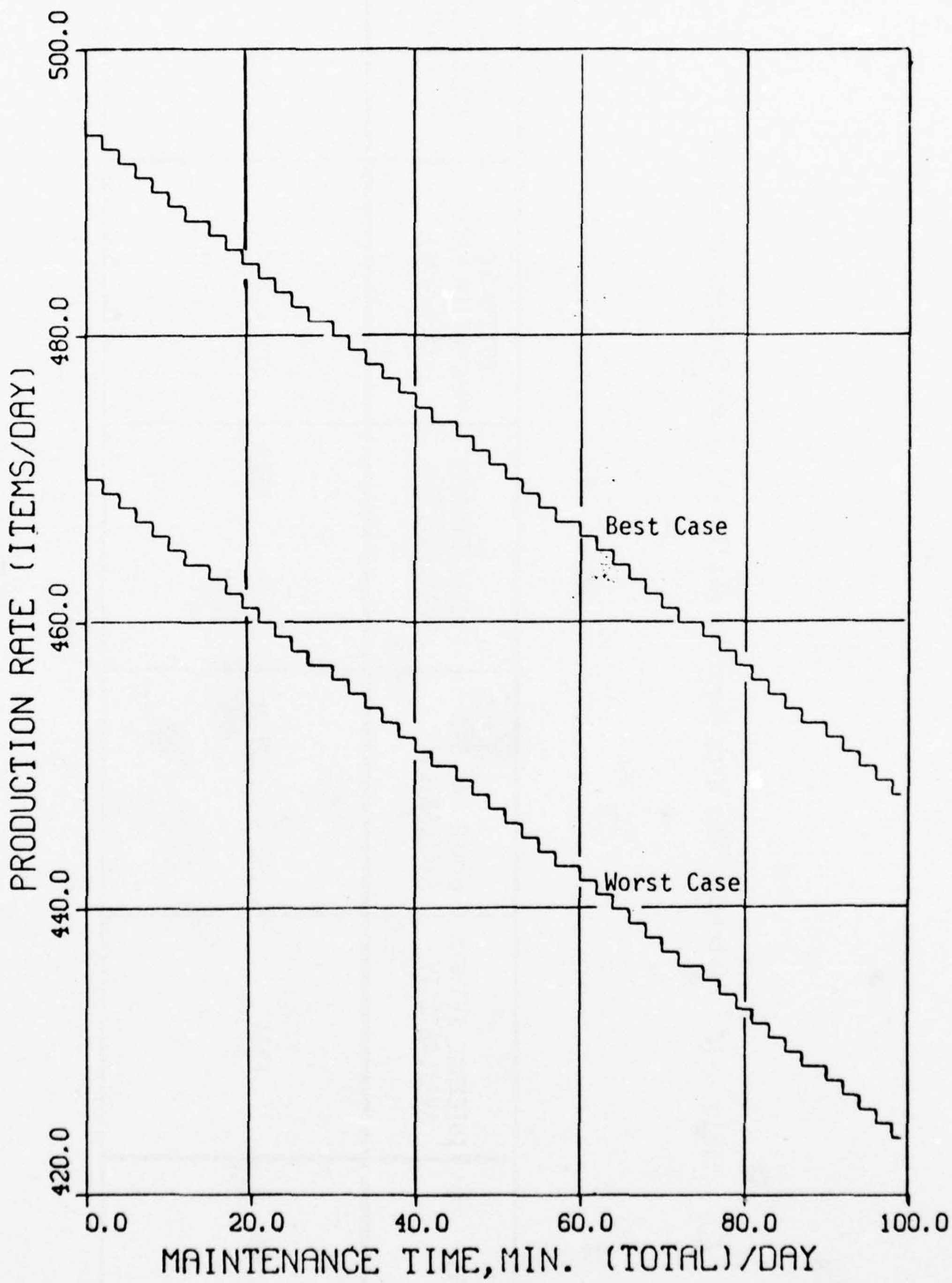

Figure 4-12. Relation Between Production Rate and Maintenance Time, Cartridge, 105 mm, M360, GB, with Bursters

4.3.4 Projectiles, Mustard With Bursters

Figure 6-13 illustrates schematically, the demil system for mustard fill burstered projectiles which is fundamentally similar to the production line f GB/VX filled burstered projectiles. The primary difference being GB/VX projectiles are drained by the PPD and mustard projectiles are not. As such, similar to the GB/VX burstered projectile line, momentary shutdown of certain elements can be accommodated without affecting the processing rates. All elements however, must function to sustain production.

Evaluation of the processing capabilities of the building blocks identif the PDM as the production limiting subsystem. Projected processing rate of 1 mustard filled burstered projectiles of the PDM as well as the demil line is per hour.

Periodic replacement of dull projectile nose closure cutting saw blades is the only operational maintenance activity requiring shutdown of the production line. However, as indicated in Paragraph 6.3, saw blade replacement is readily accomplished and could be effected with minimal disruption of munitions production. No down time is anticipated to replace dull burster saw blades as it is projected that these blades have a cutting life which would permit replacement during scheduled maintenance down times with adequate blade life margins.

No preventive maintenance actions have been identified which would requi shutdown of the production line.

Equipment failure and repair time data for each of the projectiles, mustard with bursters configurations are presented in Tables 4-16 and 4-17. The range of availability including external factors and the resulting production rates are given in Table 4-18. These rates do not include maintenance times which reduce production. Any down time for maintenance will reduce the production rates as indicated in Figure 4-14.

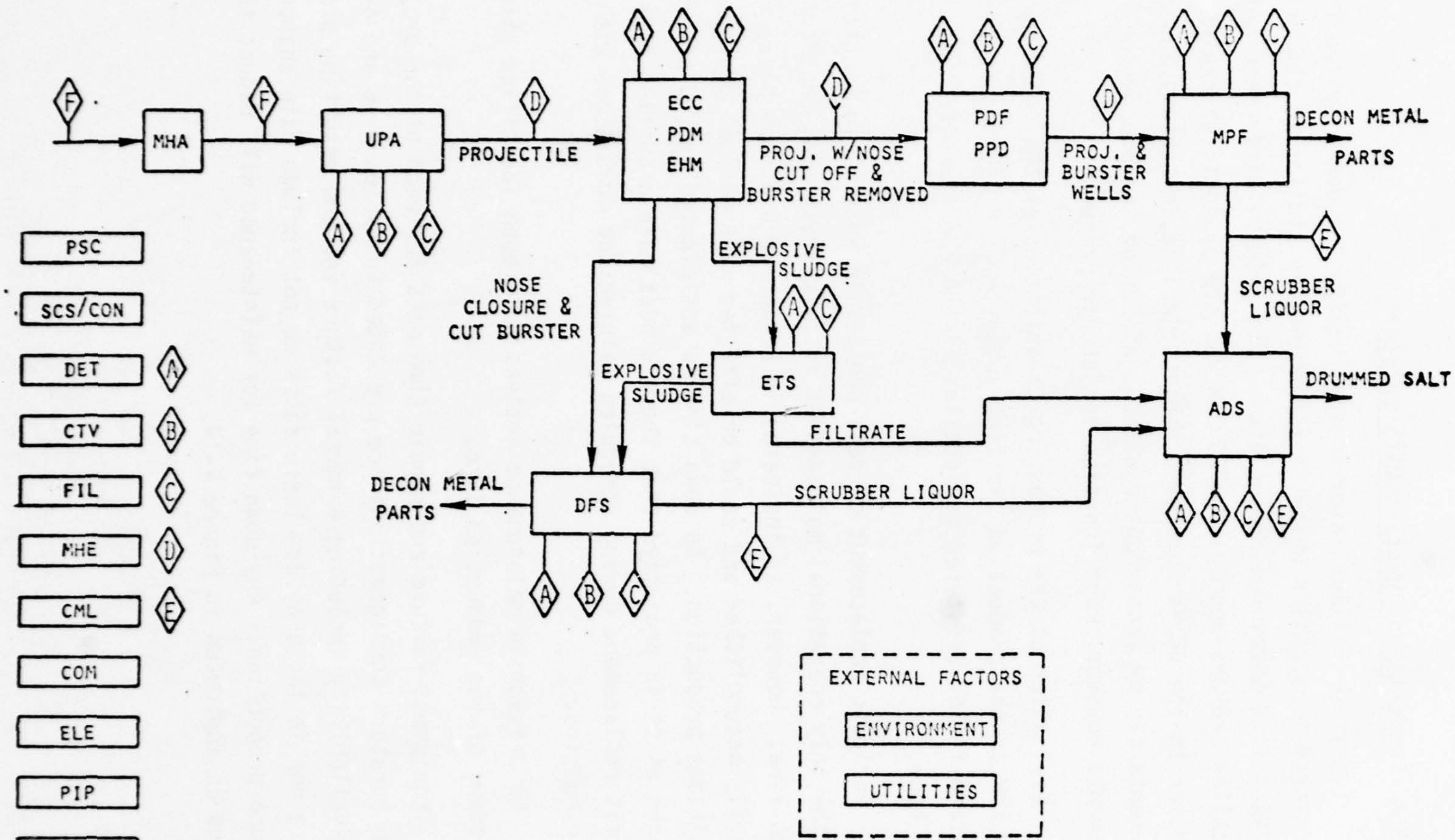

Figure 4-13 Munition Demil Sy. m - Projectiles, Mustard

Table 4-16. Availability Parameter Summary - Projectile, 155 mm M110, Mustard with Bursters

Building Block	Nλ	MTBF	NλTM	MTTR	Availability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Explosive Containment	796.688	1255	9337.351	11.72	0.9907
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.02	0.9720
Ecc Hydraulics	2874.761	348	28797.522	10.02	0.9720
Agent Destruction System	2248.3	445	14483.4	6.44	0.9857
Explosive Treatment System	393.9	2539	2246.8	5.70	0.9978
Projectile Demil Machine	2948.017	339	37250.544	12.64	0.9641
Projectile Pull and Drain Machine	3025.018	331	31661.549	10.47	0.9693
Material Handling Equipment	3688.244	271	30547.389	8.28	0.9704
Filter System	970.3	1031	6879.4	7.09	0.9932
Piping	23.908	41827	64.232	2.69	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	35048.6	28.5	259079.0	7.4	0.7942

Table 4-17 Availability Parameter Summary - Projectiles, 155mm, M104 Mustard With Bursters

Building Block	Nλ	MTBF	NλTM	MTTR	Availability
Unpack Area	241.039	4149	584.843	2.43	0.9994
Explosive Containment Cubicle	796.688	1255	9337.351	11.72	0.9907
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	2874.761	348	28797.522	10.02	0.9720
Ecc Hydraulics	2874.761	348	28797.522	10.02	0.9720
Agent Destruction System	2248.3	445	14483.4	6.44	0.9857
Explosive Treatment System	393.9	2539	2246.8	5.70	0.9978
Projectile Demil Machine	2948.017	339	37250.544	12.64	0.9641
Projectile Pull and Drain Machine	3025.318	331	31661.549	10.47	0.9693
Material Handling Equipment	3688.244	271	30547.389	8.28	0.9704
Filter System	970.3	1031	6879.4	7.09	0.9932
Piping	23.908	41827	64.232	2.69	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munitions Process	35048.6	28.5	259079.0	7.4	0.7942

Table 4-18. Projectiles, Mustard With Bursters Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
155, M110	.7942	.95 - .999	.7545 - .7934	507 - 533	650
155, M104	.7942	.95 - .999	.7545 - .7934	507 - 533	650

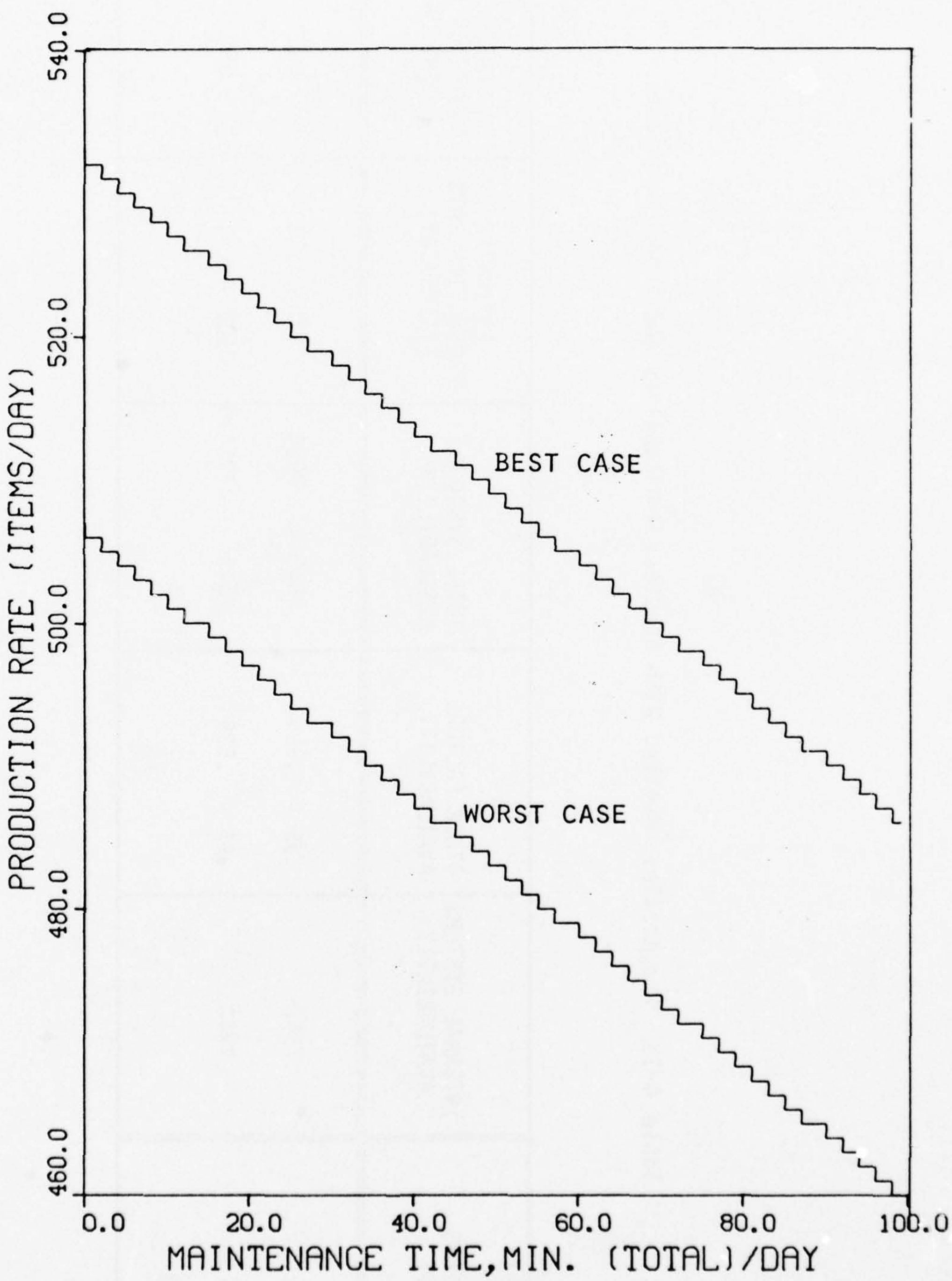

Figure 4-14. Relation Between Production Rate and Maintenance Time, Projectile, 155 mm, M110, Mustard with Bursters and Projectile, 155 mm, M104, Mustard with Bursters

4.3.5 M23 Mine, VX

The system for the demil of M23 Mines is shown schematically in Figure 4-15. All building blocks shown must function to sustain production. Loss of supportive building blocks can be accommodated for varying periods without disrupting production; however, long term loss of supportive building blocks will affect production and shut down the production line.

Evaluation of the processing capabilities of the building blocks indicate that production of M23 mines will be limited by the MIN machine which is designed to process 40 mines per hour. With the exception of the ADS, which can be shut down as long as the agent neutralization tanks can store (accumulate) agent from the ECC, the M23 mine production line is without elements with significant accumulation capacity; partial shut down of the line without disrupting production for maintenance is therefore not possible. Since, however, no operational or preventive maintenance action can be identified which would require partial shutdown of the line, maintenance requirements will not affect production rate.

The punches in the MIN machine, as well as the associated seals, will require periodic replacement. Current projections indicate this can be accomplished during schedule downtimes and will not affect production rates.

Equipment failure and repair time data for the M23 mine configuration is presented in Table 4-19 The range of availability including external factors and the resulting production rates are given in Table 4-20. These rates do not include maintenance times which reduce production. Any down time for maintenance will reduce the production rates as indicated in Figure 4-16.

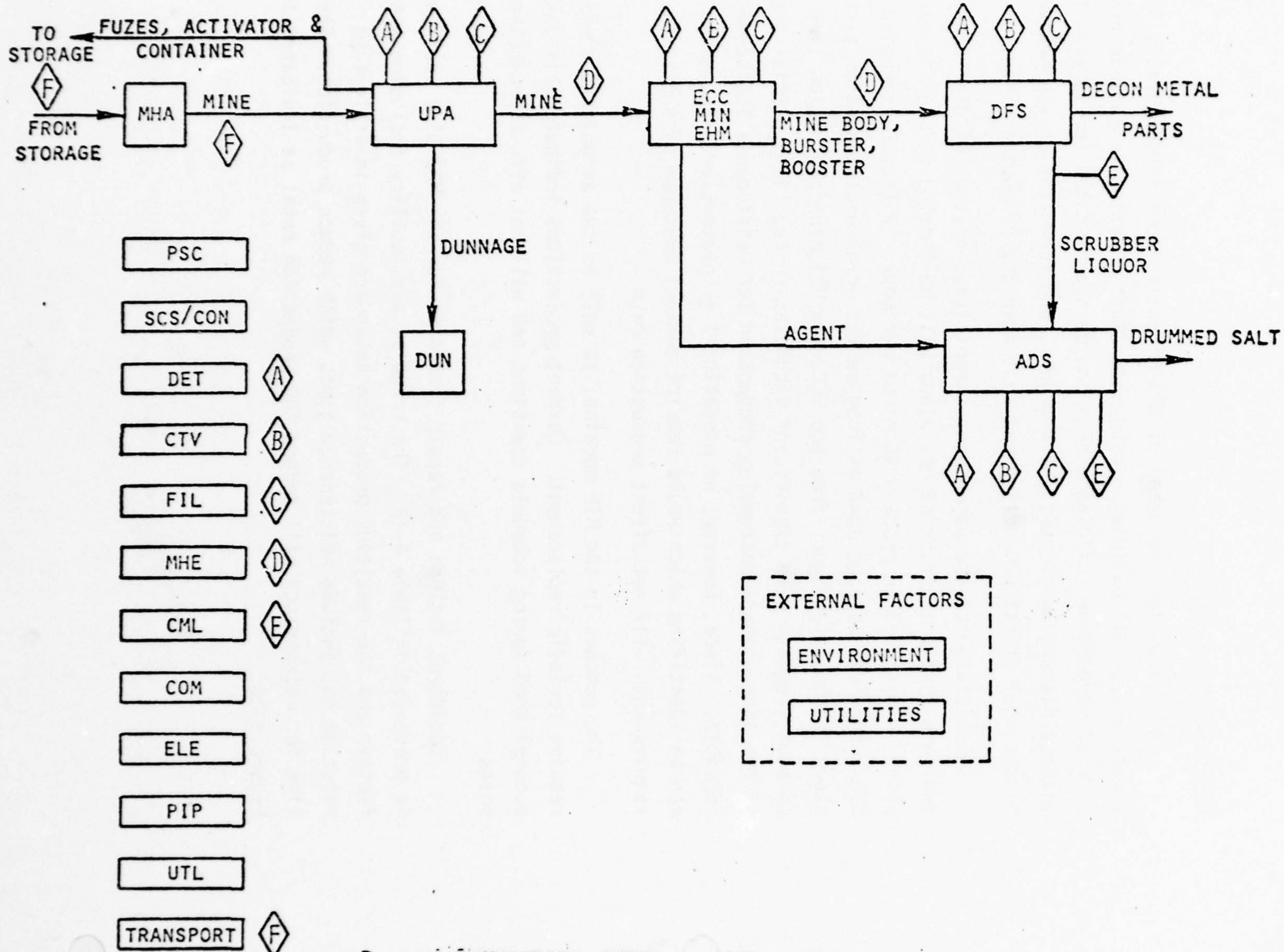

FIGURE 4-15 MUNITION DEMIL SYSTEM - M23 MINE, VX

Table 4-19. Mine, 2 Gallon, M23, VX Availability Parameter Summary

Building Block	N λ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	Neg	N/A	Neg.	N/A	≈1.0
Explosive Containment Cubicle	802.360	1246	9556.234	11.91	0.9905
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Utilities	Neg	N/A	Neg.	N/A	≈1.0
ECC Hydraulics	3497.954	286	11655.711	10.00	0.9662
Agent Destruction System	4769.1	210	35993	7.55	0.9653
Material Handling Equipment	59.586	16783	361.134	6.06	0.9996
Filter System	553.2	1808	3925.4	7.10	0.9961
Mine Demil Machine	2775.954	360	38759.304	13.96	0.9627
Piping	50.775	19695	149.496	2.94	0.9998
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350.	2857.1	1.0	0.9972
Total Munition Process	23092.0	43.3	130432.7	5.6	0.8846

Table 4-20. Mine, 2 Gallon M23, Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
M23 Mine	.8846	.95 - .999	.8404 - .8837	806 - 848	800

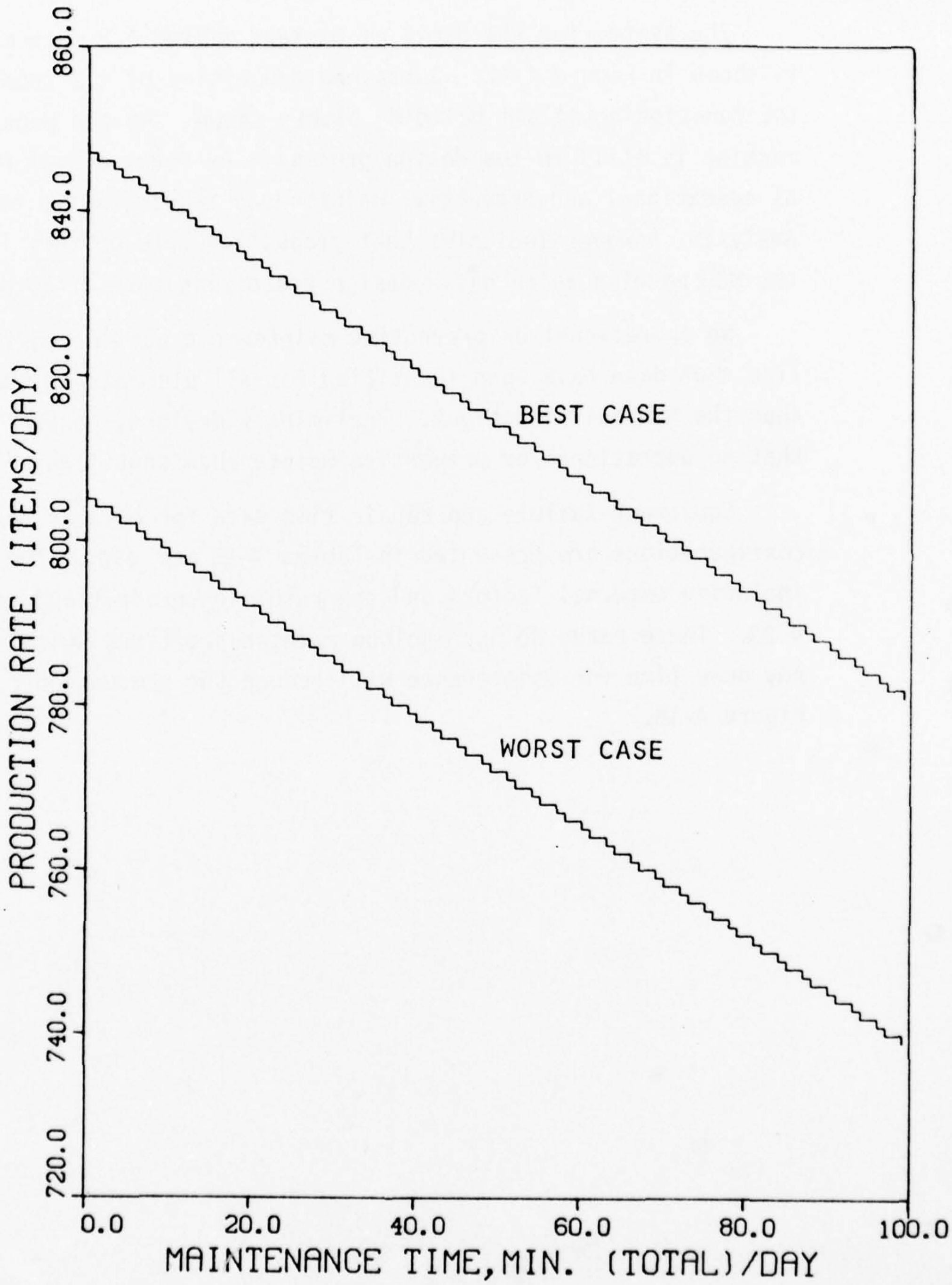

Figure 4-16 Relation Between Production Rate and Maintenance Time, M23 MIne, VX

4.3.6 4.2 Inch Mortar, Mustard

The system for the demil of mustard filled 4.2 inch mortar cartridges is shown in Figure 4-17. Sustained processing of 4.2 inch mortars require the functioning of all building blocks shown. At the present time, the MOR machine is still in the design process. As such, actual production rates, as w as operational and preventive maintenance requirements, can not be fully identi Analysis, however indicates that production rate of this lime will be limited b the MOR machine which has a design processing rate of 50 mortars per hour.

No operational or preventive maintenance action requiring production line shut down have been identified for all elements in the system other than the MOR building block. Preliminary designs, however, of the MOR suggest that no operational or preventive maintenance shut down will be required.

Equipment failure and repair time data for each of the 4.2" mortar configurations are presented in Tables 4-21 and 4-22. The range of availabilit including external factors and the resulting production rates are given in Tabl 4-23. These rates do not include maintenance times which reduce productic Any down time for maintenance will reduce the production rates as indicated in Figure 4-18.

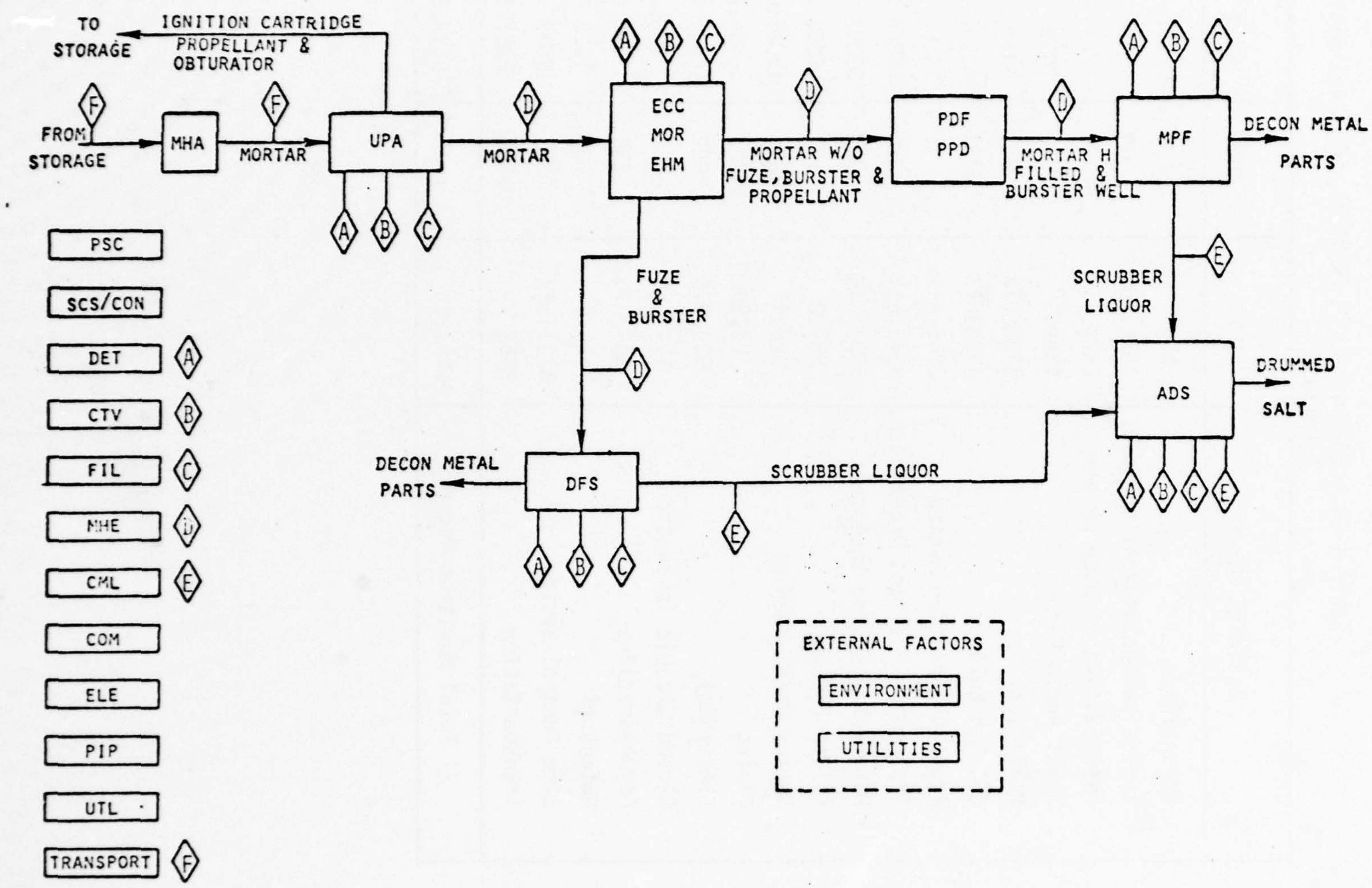

FIGURE 4-17 MUNITION DEMIL SYSTEM - 4.2" MORTAR, MUSTARD

Table 4-21. Mortar, 4.2", M2/M2A1, HD, Availability Parameter Summary

Building Block	N λ	MTBF	NλTM	MTTR	Avail abili
Unpack Area	Neg	N/A	Neg	N/A	≈1.0
Explosive Containment Cubicle	1074.292	931	12350.705	11.50	0.981
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.982
Metal Parts Furnace	4380.3	228	38396	8.77	0.963
Utilities	4328.878	231	43193.280	9.98	0.958
ECC Hydraulics	4328.878	231	43193.280	9.98	0.958
Agent Destruction System	2248.3	445	14483.4	6.44	0.985
Projectile Pull and Drain Mach.	4342.658	230	45566.522	10.49	0.956
Material Handling Equipment	3303.338	303	33099.942	10.02	0.968
Filter System	887.0	1127	6291.8	7.09	0.993
Mortar Demil Machine	922.44	1084	13027.7	14.12	0.987
Piping	23.908	41827	64.232	2.69	0.999
Electrical	509.916	1961	1031.496	2.02	0.997
Closed Circuit Television	114.155	8760	228.310	2.0	0.999
Communications	365.296	2738	1095.888	3.0	0.998
Detectors	1428.6	700	1428.6	1.0	0.998
Site Control System	2787.872	359	5973.744	2.14	0.994
Transportation	2857.1	350	2857.1	1.0	0.997
Total Munition Process	36423.0	27.4	279699.3	7.7	0.781

Table 4-22. Mortar, 4.2", M2/M2A1, HT, Availability Parameter Summary

Building Block	N λ	MTBF	NλTM	MTTR	Avail-ability
Unpack Area	Neg	N/A	Neg	N/A	≈ 1.0
Explosive Containment Cubicle	1074.292	931	12350.705	11.50	0.9878
Deactivation Furnace System	2520.1	397	17417.3	6.91	0.9829
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	4328.878	231	43193.280	9.98	0.9586
ECC Hydraulics	4328.878	231	43193.280	9.98	0.9586
Agent Destruction System	2248.3	445	14483.4	6.44	0.9857
Projectile Pull and Drain Mach.	4342.658	230	45566.522	10.49	0.9564
Material Handling Equipment	3303.338	303	33099.942	10.02	0.9680
Filter System	887.0	1127	6291.8	7.09	0.9937
Mortar Demil Machine	922.44	1084	13027.7	14.12	0.9871
Piping	23.908	41827	64.232	2.69	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Site Control System	2787.872	359	5973.744	2.14	0.9941
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	36423.0	27.4	279699.3	7.7	0.7814

Table 4-23. 4.2" Mortar, Availability and Production Rate

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
M2/M2A1, HD	.7814	.95 - .999	.7423 - .7806	890 - 936	1000
M2/M2A1, HT	.7814	.95 - .999	.7423 - .7806	890 - 936	1000

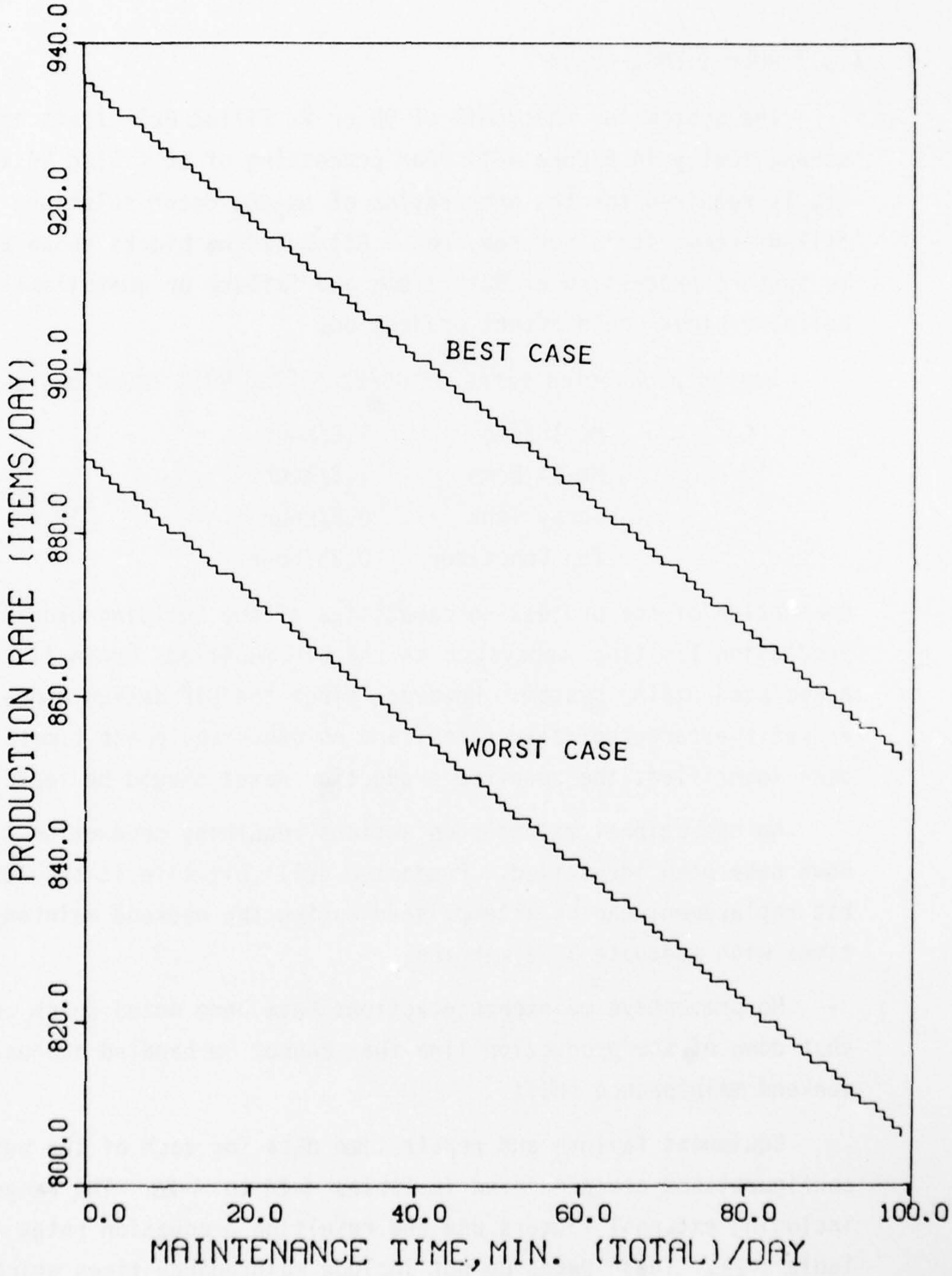

Figure 4-18. Relation Between Production Rate and Maintenance Time, Mortar, 4.2", M2/M2A1, HD and Mortar, 4.2", M2/M2A1, HT

4.3.7 BULK ITEMS, GB/VX

The system for the demil of GB or VX filled Bulk Items is shown schematically in Figure 4-19. For processing of GB filled Bulk Items, the ETS is required for the preparation of Na_2CO_3 decon solution; for VX filled items, it is not required. All building blocks shown are required to support processing of Bulk Items and failure or unavailability of any building block would affect production.

Design production rates of GB/VX filled Bulk Items are as follows:

MC-1 Bomb	1.2/hour
MK-94 Bomb	1.2/hour
Spray Tank	0.2/hour
Ton Container	0.25/hour

Evaluation of the processing capacities of the building blocks identify the production limiting subsystem as the BIF munitions drain fixtures and the associated piping system. However, since the BIF design processing rates exceed the targeted daily rates, and no other equipment limitations have been identified, the required production rates should be realized.

No operational maintenance actions requiring production line shut down have been identified. Projected drill bit life is such that dull drill bit replacement can be accomplished during the weekend maintenance down times with adequate life margins.

No preventive maintenance actions have been noted which would require shut down of the production line that cannot be handled adequately during a weekend maintenance shift.

Equipment failure and repair time data for each of the bulk item configurations are presented in Tables 4-24 to 4-28. The range of availability including external factors and the resulting production rates are given in Table 4-29. These rates do not include maintenance times which reduce production. Any down time for maintenance will reduce the production rates as indicated in Figure 4-20 for the 750 lb bomb and MK94 bomb. The production rate other configurations will reduce by one item per day for maintenance time of two hours.

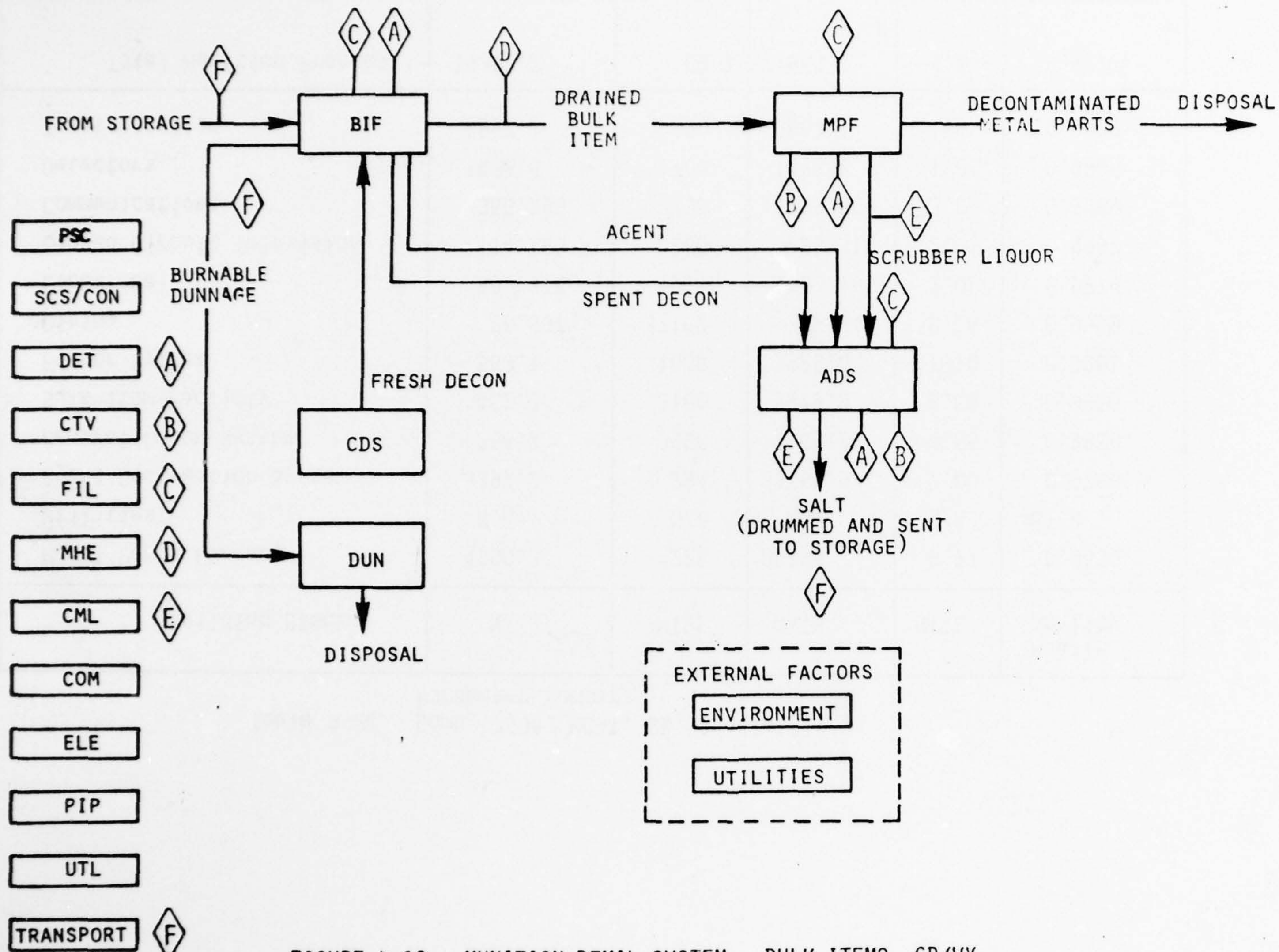

FIGURE 4-19. MUNITION DEMIL SYSTEM - BULK ITEMS, GB/VX

Table 4-24. Bomb, 750#, MC-1, GB, Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	≈1.0
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Bulk Item Facility	462.9	2160	3979.8	8.60	0.9960
Filter System	553.1	1808	3925.0	7.10	0.9961
Piping	26.891	37187	87.644	8.26	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	14352.2	69.7	77964.9	5.4	0.9277

Table 4-25. Bomb, MK94, GB, Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	≈1.0
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Bulk Item Facility	560.4	1784.4	5028.7	8.97	0.9950
Filter System	553.1	1808	3925.0	7.10	0.9961
Piping	26.891	37187	87.644	8.26	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9987
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	350	0.9972
Total Munition Process	14449.7	69.2	79013.8	5.5	0.9268

Table 4-26 Tank, Spray, TMU-28/B, VX Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	$\approx$1.0
Agent Destruction System	4769.1	210	35993	7.55	0.9653
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Bulk Item Facility	587.4	1702	5644.2	9.61	0.9944
Filter System	553.1	1808	3925.0	7.10	0.9961
Piping	26.891	37187	87.644	3.26	0.9999
Electrical	509.916	1961	1036.496	2.06	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	15848.6	63.1	91856.4	5.8	0.9159

Table 4-27 Ton Container, GB, Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	$\approx$1.0
Agent Destruction System	3397.2	294	23765.9	7.00	0.9768
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Bulk Item Facility	486.6	2055	4562.8	9.38	0.9955
Filter System	553.1	1808	3925.0	7.10	0.9961
Piping	26.891	37187	87.644	3.26	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	14375.9	69.6	78547.9	5.5	0.9272

Table 4-28. Ton Container, VX, Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Avail-ability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	≈1.0
Agent Destruction System	4769.1	210	35993	7.55	0.9653
Central Decon System	256.7	3896	1169.2	4.55	0.9988
Bulk Item Facility	486.6	2055	4562.8	9.38	0.9955
Filter System	553.1	1808	3925.0	7.10	0.9961
Piping	26.891	37187	87.644	3.26	0.9999
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	15747.8	63.5	90775.0	5.8	0.9168

Table 4-29. Bulk Items, GB/VX, Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
Bomb, 750#, GB	.9277	.95 - .999	.8813 - .9268	25 - 26	24
Bomb, MK94, GB	.9268	.95 - .999	.8805 - .9259	25 - 26	24
Spray Tank, VX	.9159	.95 - .999	.8701 - .9150	4	4
Ton Container, GB	.9272	.95 - .999	.8808 - .9263	5	5
Ton Container, VX	.9168	.95 - .999	.8710 - .9159	5	5

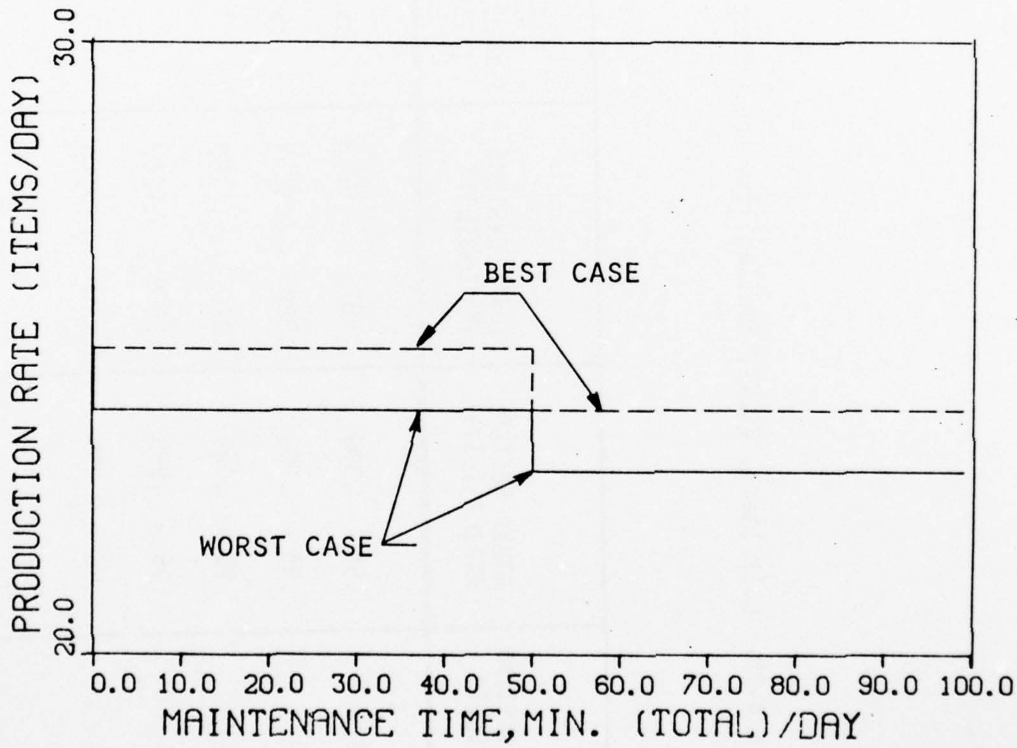

Figure 4-20. Relation Between Production Rate and Maintenance Time, MC-1 Bomb, 750#, GB and MK94 Bomb, GB.

4.3.8 Ton Containers, Mustard

The system for the demil of mustard filled Ton Containers is shown schematically in Figure 4-21. Only two major building blocks are directly involved. However, unavailability of any of the supportive building blocks affects production, eventually if not immediately, and will shut down the production line if unavailability is long term.

Evaluation of the processing rate of mustard filled Ton Containers identi the MPF as the production limiting subsystem. Maximum production of Ton Containers would be one container every four hours which is the MPF Ton Container design processing rate.

No operational or preventive maintenance actions have been identified which would require a nonscheduled shutdown of the production line.

Equipment failure and repair data for the Ton Containers with mustard configuration is presented in Table 4-32. The range of availability including external factors and the resulting production rates are given in Table 4-33. These rates do not include maintenance times which reduce production. Any down time for maintenance up to two hours will reduce production to four items per day.

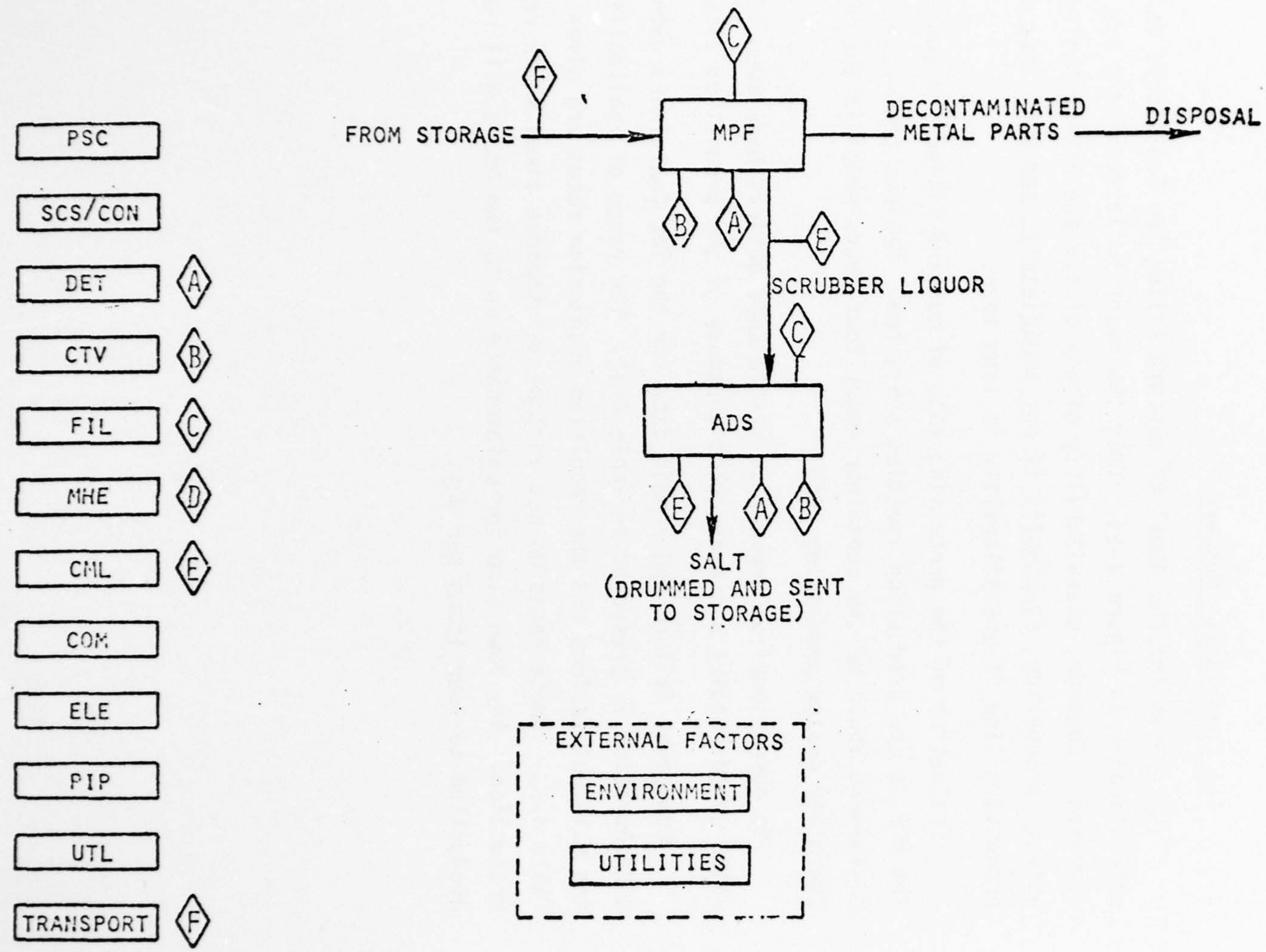

Figure 4-21 Munition Demil System - Ton Container, Mustard

Table 4-32 Ton Container, Mustard, Availability Parameter Summary

Building Block	$N\lambda$	MTBF	$N\lambda TM$	MTTR	Availability
Metal Parts Furnace	4380.3	228	38396	8.77	0.9630
Utilities	Neg	N/A	Neg	N/A	≈ 1.0
Agent Destruction System	2248.3	445	14483.4	6.44	0.9857
Filter System	459.3	2177	3261.9	7.10	0.9967
Piping	9.577	104412	27.121	2.83	≈ 1.0
Electrical	509.916	1961	1031.496	2.02	0.9979
Closed Circuit Television	114.155	8760	228.310	2.0	0.9997
Communications	365.296	2738	1095.888	3.0	0.9989
Detectors	1428.6	700	1428.6	1.0	0.9986
Transportation	2857.1	350	2857.1	1.0	0.9972
Total Munition Process	12372.5	80.8	62809.8	5.1	0.9409

Table 4-33 Ton Container, Mustard, Availability and Production Rates

MUNITIONS TYPE	INTERNAL SYSTEMS AVAILABILITY	OTHER FACTORS AVAILABILITY	TOTAL SYSTEMS AVAILABILITY	ESTIMATED PRODUCTION RATE (ITEMS/DAY)	TARGET PRODUCTION RATE (ITEMS/DAY)
Ton Container	.9409	.95 - .999	.8939 - .9399	5	5

4.4 PRODUCTION DURING SYSTEM START-UP

Assuming adequate design and functional testing has occurred, the two major factors that affect production during system start-up are high initial failure rates due to "infant mortality" and inexperienced operator/maintenance personnel. Infant mortality can be reduced by "burn in" of components for a period of 5-10% of their expected MTBF. Some burn-in will occur naturally during subsystem and functional tests. However, a system burn-in time of 250-350 hours is not excessive, and until this much production time is on the total system, excessive component failures can be expected. Based on initial one-shift/day operation and assuming failures are three times normal during the first 100 production time hours, two times normal during the second, and 50% more than normal during the third, and also assuming average repair times can be managed, system production for the first operational configuration the M55 Rocket, would be as shown in Table 4-34. Personnel learning curves are not available for situations found in CAMDS but it would be reasonable to estimate that production capability would be reduced significantly further, say 10% more in each month, with steady state rates not reached until the fifth month. The results of this scenario are shown in Figure 4-22.

The start-up effects for subsequent systems are much more complex. Succeeding munition configurations utilize many of the same building blocks used in previous configurations. As a result, infant mortality and operator proficiency probably would not be a factor in the performance of these common elements. To estimate subsequent system start-up production, the increased failures due to infant mortality and the lost time due to operator and maintenance personnel proficiency must be determined for the new elements only. Only those reductions caused by the new elements would be subtracted from the "mature" system production rates estimated in Section 4.3. To perform this estimate, the implementation order for all munition configurations is required. Since the scheduled order has not yet been determined, start-up effects for subsequent systems was not attempted. It is safe to assume however, that the percent reduction in production rates during start up for subsequent systems would fall between the percentage reduction estimated for the M55 Rockets and "mature" system levels.

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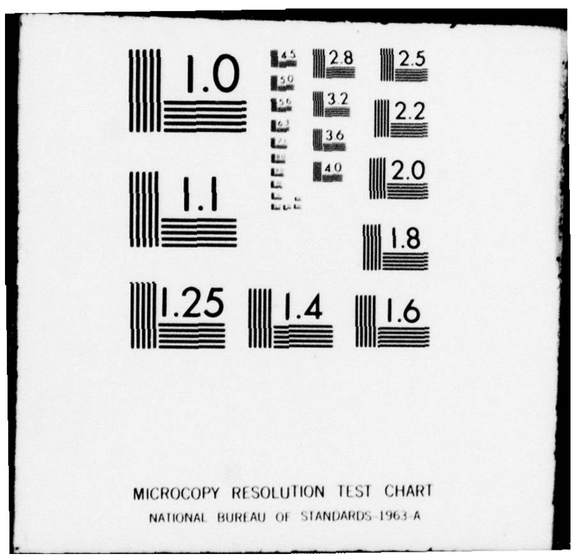
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table 4-34 Estimated M55 Rocket (GB/VX) Daily Production Rate by Month for Single Shift Operation During System Start-Up (Ignoring Learning Curve)

MONTHS FROM START-UP	ROCKETS PER DAY NO UPA SAFETY LIMITATIONS
1	79 - 83
2	90 - 96
3	99 - 102
4	104 - 109
5	104 - 109

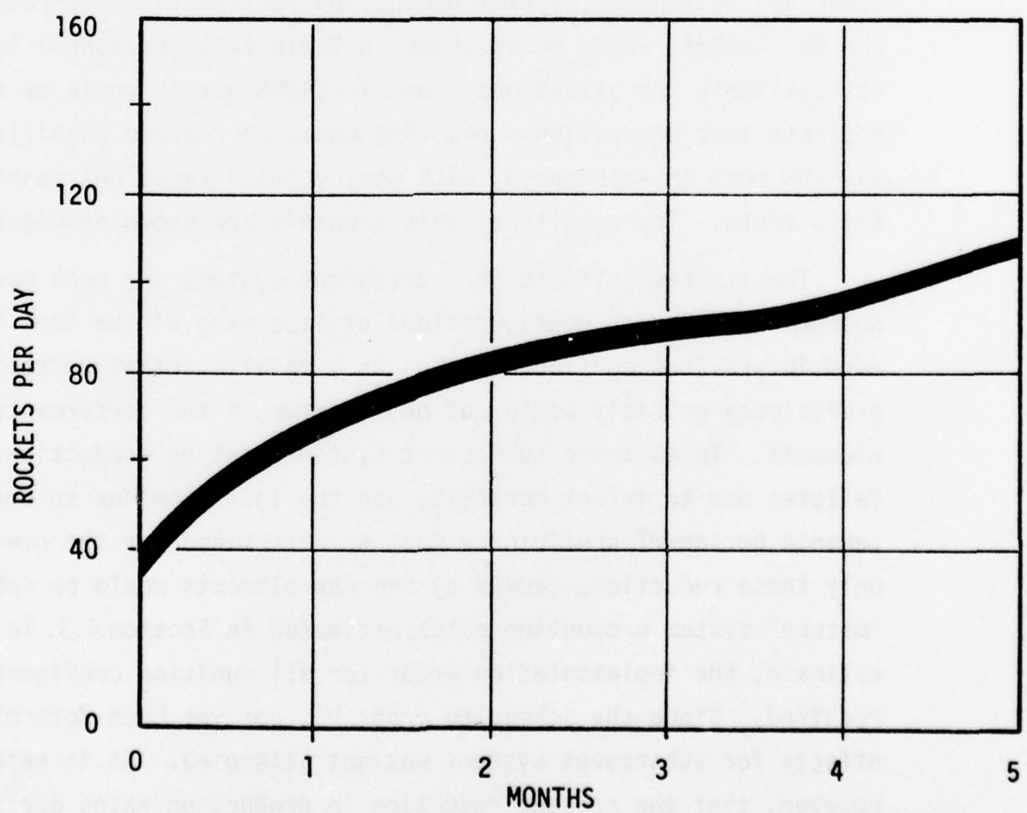


Figure 4-22 Estimated M55 Rocket (GB/VX) Daily Production Rate by Month for Single Shift Operation During System Start-Up (Including Learning Curve)

5.0 PHASE II BUILDING BLOCK LEVEL ANALYSIS

5.1 GENERAL APPROACH

Data in the form of drawings, reports, manufacturer's specifications, coupled with discussions with engineering personnel representing both Edgewood Arsenal and Tooele Army Depot, have served as the basis for indoctrination and familiarization with each of the 37 building blocks which comprise the CAMDS facility. In many instances the building blocks had progressed in fabrication, assembly, and construction far enough to warrant on-the-spot evaluation. Test data were available in many cases, and actual tests were witnessed on occasion. The CAMDS Overall Test Program Resume, Revision No. 2, dated 12 February 1975, was also made available, along with the document entitled, "Design Criteria for CAMDS," dated April 1975, and in particular, Test Plan 6-15, a Pre-Acceptance Test of Rocket Demil Machine.

The Army furnished a list of all building blocks, along with the cognizant engineer from each major area of responsibility: AEO, EA, TEAD, and PMO. The assignment of personnel from the aforementioned areas to each of the CAMDS building blocks provided an excellent opportunity to obtain design and operational information with which to conduct the Reliability and Maintainability Analyses. Additionally, analyses conducted by contractors and/or suppliers were utilized for reference information.

Of the 37 building blocks which comprise the CAMDS facility currently under construction at Tooele, Utah, fifteen were isolated as being exempt from the intent and purposes of this effort. The remaining twenty-two blocks noted in Section 3.3, were identified as having direct operational impact on the total CAMDS. Since this particular phase of the Reliability and Maintainability Program Analysis is concerned with the block level operation only, emphasis was placed upon block assessment.

In general, the approach of this study was to determine the Building Blocks with direct impact upon CAMDS munition processing operations, identify all component and/or modules making up those blocks, analyze all pertinent hardware for all reliability and maintainability characteristics and quantify these; and finally to determine availability of blocks for the processing of munitions by proper application and combination of respective reliability and maintainability factors. This latter analysis has been presented in data format for both building block availability parameters and munition availability parameters to facilitate use of the parameters for other phases of this contract and for customer edification.

In as much as this entire effort concerns CAMDS reliability, maintainability and resultant availability, a general discussion of these three basic disciplines appears appropriate.

5.1.1 Reliability, Maintainability, and Availability

The three major areas of concern in this phase of the contracted Reliability/Maintainability Program Analysis involve reliability, maintainability, and availability. Reliability is important from the standpoint of successfully operating the CAMDS for required periods of time. Maintainability analysis is vital so that anomolous condition corrections may be planned and systems may be quickly and efficiently restored to operable condition. Availability is the end result of the prior two areas and denotes the fraction of total time that the system is operable. Quantified, with combined results, the effects of reliability and maintainability can be shown to result in an integrated availability of the building blocks of the CAMDS as they are required to service the various munition types.

Reliability, maintainability, and availability have been defined, in Section 3.4. Quantified data are presented throughout this report and specific equations are developed later in the report. A brief examination of the nature of the three elements which are the basis of this analysis should be made.

The generally accepted definition for reliability as noted in Section 3.4 is stated as the probability that a specified function will be performed for a specified time under given conditions. It is, briefly the chance that an item in question will "work". The definition points out the need to know certain basics, i.e., required time of operation, environment of operation and criterion for successful operation. The result of applying this definition is a quantitative value for reliability.

The reliability of many items is dependent upon the length of time that they must operate, with the reliability of one item affected by time more than that of another item. And obviously, the probability of failure per unit time, a failure rate, is or can be, different for different operating conditions. For these reasons then, reliability is noted as a probability conditional upon specified operating conditions and time. In any specified unit of time divided into intervals, one of the following is true. An item which does not fail in a particular time interval has the same probability of failure in the successive time interval as it had at the beginning of the prior time interval. In other words, the probability of failure per time interval does not change as the item operates successfully through consecutive intervals. This phenomenon is referred to as a "constant failure rate." An item which does not fail in a particular time interval has a different probability of failure in the successive time interval than it had at the beginning of the prior time interval. This situation would apply, for instance, to any item which is wearing out. The item is said to have a "variable failure rate."

Figure 5-1 is a classic failure frequency distribution curve commonly called a "bathtub" curve which has been found to approximate the operating life cycle of a majority of electronic and mechanical components, and even complex systems. The "debugging" or infant mortality area is due to early failure of weak items, inadequate quality control, and manufacturing errors. Systems placed into operation will hopefully no longer reside in this area but will be operating in the "normal" operating or "useful life" period. During this period the probability of failure per unit time (rate) is approximately constant. Failures in this period occur merely as a matter of chance and are entirely random in nature. It has been found that the reliability of time dependent items with a constant failure rate may be

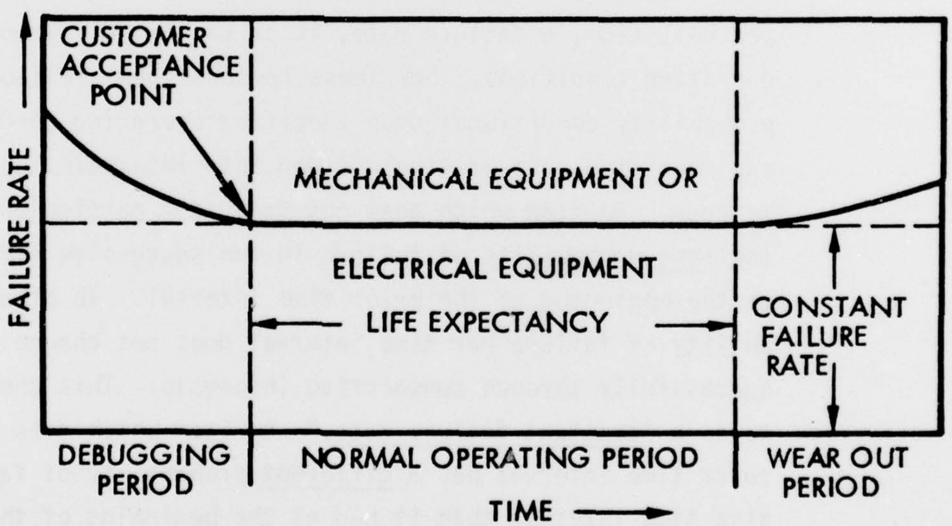


Figure 5-1. Classic Failure Rate Curve

described by an exponential function. Reliability can then be derived to yield the equation $R = e^{-\lambda t}$, where λ is the only parameter-failure rate in failures per hour (or multiple), and t is the single variable, operating or exposure time, in hours. The reliability function assumes a value of unity at time zero and decreases exponentially toward zero as time approach infinity. The wear-out part of the life cycle curve is where cummulative effects on long operation begin to show and failure rates increase.

Another measure of the failure rate expectancy is the mean-time-betwee failures (MTBF) which is the average operating time between failure occurrences. An estimate of $\widehat{MTBF}$ can be obtained from operational data (for the analyses, data from RADC compiled sources have been extensively used) from the relationship:

$$\widehat{MTBF} = \frac{\text{total operating time}}{\text{total of failures}}$$

Calculation of a $\widehat{MTBF}$ does not necessarily imply that a constant failure rate exists, but if such is the case then the exponential distribution is applicable. The MTBF then is the reciprocal of λ, the constant failure rate, or:

$$MTBF = 1/\lambda$$

The exponential reliability function then may be alternatively written:

$$\text{Reliability: } R = e^{-t/MTBF}$$

For certain items, it is more convenient to measure operating time in terms of cycles of operation. For such items, all operated to failure, the mean-cycles-between-failures (MCBF) is the average number of operating cycles before failure occurs. Just as for MTBF, the MCBF is estimated from observed data by the relation:

$$\widehat{MCBF} = \frac{\text{Total number of operating cycles}}{\text{Total number of failures}}$$

And, if the exponential distribution is applicable, then the MCBF is the reciprocal of λ and the reliability function may be written:

$$\text{Reliability: } R = e^{-n/MCBF}$$

where; n = specified number of operating cycles.

The exponential distribution and related formulas discussed above are used extensively in reliability analysis to estimate the probability of failure during a specified time interval where the assumption of a constant failure rate is applicable. These formulas, however, do not provide an estimate of the time of replacement for any particular item. For this reason, when the constant failure rate applies, a successfully operating item should not be replaced unless some other criterion is used. If a number of items are in use, however, as in any of the complex Building Blocks or their subsystems, it is possible to predict the probable number of components which will fail during many operating periods. This information may be used to determine the rate for spares provisioning.

The definition of maintainability is similar to that for reliability and is as follows: "Maintainability is the probability that, when maintenance action is initiated under stated conditions, a failed system will be restored to operable condition within a specified time." Section 3.4 includes all pertinent definitions. Maintainability is a function of several primary factors: the design of the equipment, the personnel who will perform maintenance, and the support facilities. Design includes the provision of test equipment, built-in diagnostic aids, accessibility, etc. Personnel encompasses the skill level of the people to be used. Support includes the availability of tools and test equipment at a particular place, the provision of spare parts, and the organization responsible for maintenance.

The maintainability calculations are noted in detail in Section 5.2.3 and will not be repeated here. In general, however, two maintainability quantities are of importance, the mean time between failures (MTBF) and the mean times to repair (MTTR). As noted above, the MTBF is a derivative of the reliability failure rates in an exponential distribution. For our purposes considering any Building Block, the MTBF is equated to the reciprocal of the summation of the number of like components, times the failure rate of the component. The mean time to repair or "reparability" of the component, or series of components of a Building Block, is concerned only with the active diagnosis, repair (remove and replace), and checkout of equipments by maintenance personnel. Data are required for the prediction of repairability, just as for the prediction of reliability, and again all available sources, including CAMDS personnel at TEAD, were investigated for applicable data. Repair times utilized are those which affect system downtime, involving replacement of defective units with good ones and with major defect repairs, effected elsewhere. MTBF and MTTR values are noted and calculated by Building Block component on the series of "Equipment Information and Failure/Maintainability Data" sheets included in Volume II. As with any new system a principal problem with maintainability calculations is the lack of discrete information such as the relationships between the probability of failure of a particular unit and its basic design, the diagnostic aids available and the level of competence of maintenance personnel. Once again the value of extensive testing prior to systems turn-on must be emphasized.

Finallv, the availability of Building Block systems to process each type of munition is of paramount importance. With the definition of Section 3.4 of availability as "a measure of the degree to which an item (component and subsystem) is in an operable condition when required," it is easy to see that a system "up" condition is a function of many imputs. Herein, we have considered the impact of reliability and maintainability factors only. However, additional factors of transportability, spares provisioning, job man-loading levels and other environmental factors must be considered for ultimate availability levels. For our purposes availability is set equivalent to system uptime, divided by system uptime + downtime, or $A = \frac{1}{1 + \frac{MTTR}{MTBF}} \times 100\%$. The foundation of reliability/maintainability factors is thus evident. Figure 5-2 is an interesting chart illustrating the relationship of the ratio of MTBF/MTTR to availability levels, emphasizing the importance of maintaining good repair capabilities and good system reliability, to system availability. Processing rates are directly influenced by the availability of the system to operate. The extent of this influence is noted in the conclusions section of this report.

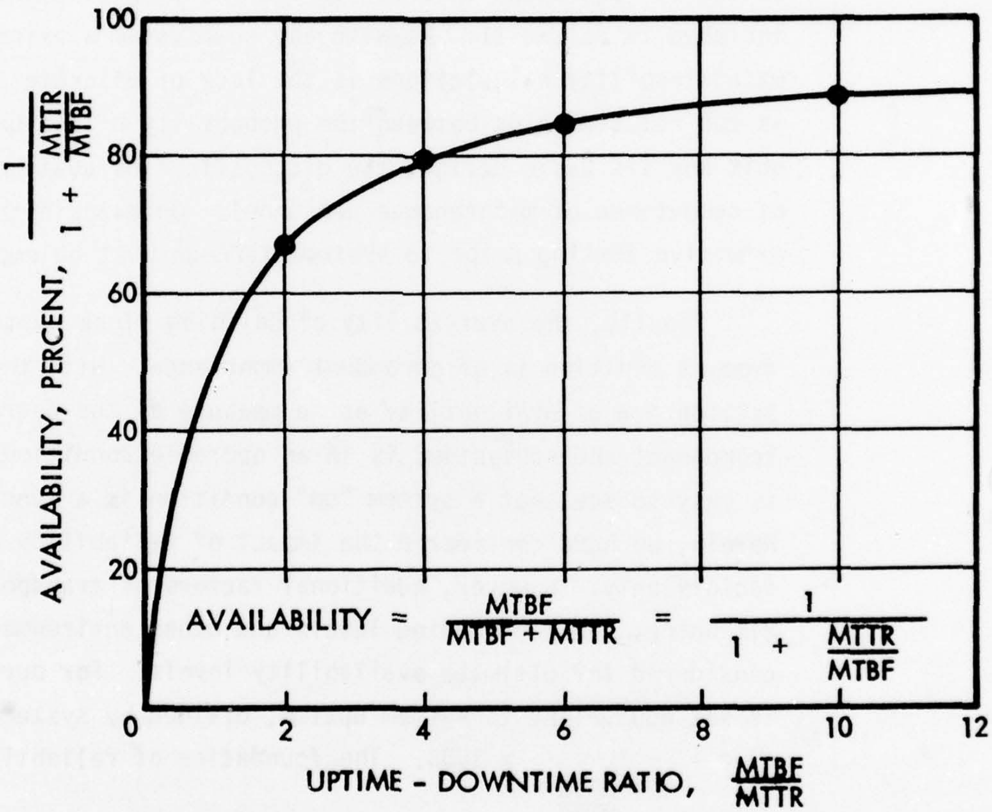


Figure 5-2. Availability vs Reliability-Maintainability Ratio

5.1.2 Specific Application

This analysis of the CAMDS production equipment has been performed to establish the base line data for use in determining the total systems availability after systems checkout and "infant mortality" time for each TEAD munitions processing application.

Several factors had a major impact on the analysis effort. These included:

1) The equipment and operational techniques were still in the development phase. In one case (the mortar demil machine) the design was still in the conceptual phase.

2) Documentation of the equipment design was limited and outdated for some Building Blocks. The drawings and demil plan ranged in some instances from sketches and drafts to third and fourth revisions of released drawings.

3) The schedule for completion of this analysis did not permit waiting for complete and final documentation for the system.

4) Basic information about equipment failure rates and maintanence times was not available from identical existing processing systems.

The approach developed for the analysis considered the above factors. The equipment items were defined by listing material from all available documentation and then (in the case of TEAD building blocks) reviewing those lists for correctness and completeness with the responsible Building Block engineers and equipment specialists. Where equipment definitions were incomplete, a "best estimate" was applied to compensate for the missing data.

The equipment used in the analysis was limited to that directly used in munitions processing. Items used solely for maintenance, diagnostic testing, emergency shutdown and supporting operations were not included. The supply of utility electrical power and water supply to the facility were not included in facility building block analyses.

Basic failure rate data used in the analysis were obtained from several sources. The most generally used data were obtained from RADC reports which contained substantial historic data on components similar to those being used in the CAMDS design. These reports were found to be the most applicable information available. Since most of the items used in CAMDS were found to have similar items in the RADC reports, the relationship of failure rates from one item to another was judged to be reasonable and applicable to CAMDS. Other sources included MIL Standard specifications, and manufacturers of the equipment involved. In a very limited number of cases a best estimate was made to assign a failure rate.

Basic maintenance time data used in the analysis were obtained from several sources. Some of the data were derived from RADC reports where they seem applicable and reasonable. In many cases, the times were a best estimate of the time required to diagnose, repair (remove and replace), and check out the repair. A minimum mean repair time of two (2) hours was used as a conservative time for unscheduled repair and restart activitie Factors were developed (and reviewed with TEAD personnel experienced in protective suit operations) to compensate for working conditions requiring protective clothing and/or work in restricted areas.

The application of the failure rate and maintenance time data was accomplished under the following ground rules:

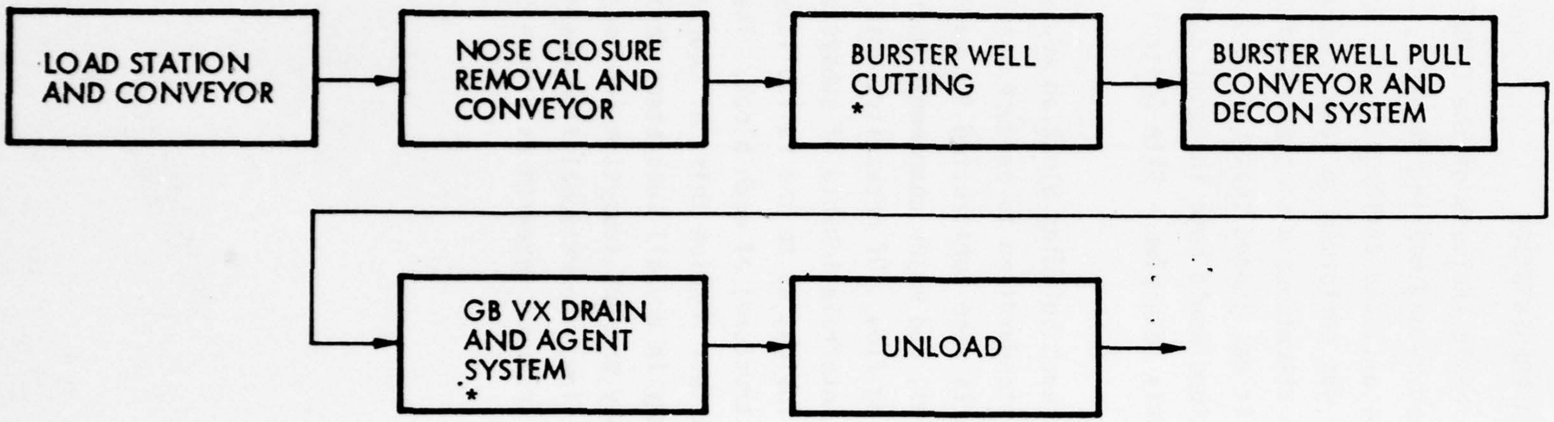
1) Rates and times were consistently applied to identical and similar items unless there was a clearly identified reason to deviate.
2) Identification of those items used at a rate of greater than 10 cycles per hour was made to accommodate the various production rates involved.
3) Every effort was made to use the data in a "conservative" manner. (This was done to compensate for missing items and uncertainty in the accuracy of the rates and times used - it makes the resulting availability of the system lower than might be obtained from an "optimistic" approach.)
4) The emphasis of the analysis was to define the total system availability. It was recognized that an individual item failure rate and repair time could be greater or less than noted, as a standard value, but the impact on the systems' availability would be minimal. (Over 8,000 individual items were identified during the analysis and up to 150 basic failure rates were applied. Evaluations were made to determine the impact of changing rates and/or times of individual items. These changes resulted in variations in the third and fourth places of Building Block availability numbers and were judged to be insignificant considering the quality of the data used for the maintenance times.)

5.2 DATA PRESENTATION

The basic analysis of the CAMDS was accomplished by Building Blocks as defined by engineering drawings. When equipment within the Building Block was utilized differently for each munitions processing activity, the analysis was performed to supply separate information for each activity. In a few situations a single set of data for all applications was used because it was judged that breaking the Building Block down to individual applications would have insignificant impact compared to using the single set of data (examples - Site Control System, Electrical, Closed Circuit TV, etc.).

For each building block an analysis package was developed whose format was standardized to produce similar data for each block. Operational flow charts were constructed for each block comprised of major subsystems, or modules, and major components which provide an impact to the munition processing flow. Of necessity, this type of approach provides an indication of interrelationship of subsystems and components and provides a general insight as to the reliability structure (e.g., series or parallel system structure) of each block. The reliability logic diagrams of Section 5.2.2 further develop this, of course. It was noted that there is minimal redundancy in any/all subsystems design so that there is a high degree of dependancy on each subsystem (and major components) to maintain a processing flow. Operational flow charts are included in Volume II, with an example included herewith as Figure 5-3.

BUILDING BLOCK: #18 PROJECTILE PULL AND DRAIN MACHINE (PPD)



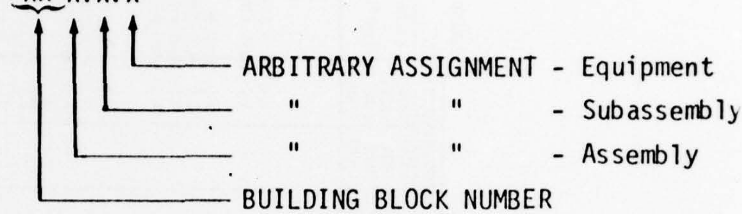
*STATIONS ACTIVATED FOR APPROPRIATE PROJECTILES

Figure 5-3. Operational Flow Chart

5.2.1 Basic Data Format

The basic element of data collection was the Equipment Information and Failure/Maintainability Data form. Figure 5-4 is a completed example of this form. The following discussion of the column headings, details the application of this form:

Item No. : XX-X.X.X



Item Name : Description listed at source documentation. Items included active functional components and generally excluded structural components. In general fittings and seals were excluded as having negligible impact on the system operation. The grouping of parts was accomplished for ease of listing and was not intended to be consistent with the flow charts.

Items identified by a Δ in this and/or other columns were considered to have cyclic dependent failure rates.

When the Equipment Information and Failure/Maintainability Data form was completed the Nλ and NλTM columns were summed for all noncyclical and cyclical items. These reflect the Nλ and NλTM for production rates at 10 units per hour. The following calculations were performed to apply the data for a specific munition process:

Production rate factors for cyclical dependent items:

TARGET PRODUCTION RATE	MULTIPLIER
20/hr	2
32.5/hr	3.25
40/hr	4
50/hr	5

Function : Description of what the item does for this application.

BUILDING BLOCK #15 PROJECTILE DEMIL MACHINE (PDM)

ITEM NO.	ITEM NAME	FUNCTION	PART NO.	MFG CODE NO.	QTY (N)	INFO. SOURCE (*)	FAIL CONSEQ (**)	RATE λ ($x10^{-6}$HR)	SOURCE (*)	Nλ	DIAGN. TIME (HR)	REPAIR TIME (HR)	CHECK-OUT TIME (HR)	TOTAL MAINT TIME TM (HR)	NλTM ($x10^{-6}$)	SOURCE (*)	REMARKS
DESCRIPTION							FAILURE DATA				MAINTAINABILITY DATA						
-10		Projectile Saw & Pump				(302)											
1.1	Saw ▲		379	Kline	1	0101	--										
1.1	Motor 3 hp ▲						2	1.206	p. 28	▲1.206				3.0	▲3.618	p. 28	Motor 3 HPAC Gnd
1.2	Gear Unit ▲						2	11.726		▲11.726				3.0	▲35.178	Est	Mech, Power Trans, Gear Box GND MOB
1.2	Pump Assy ▲	Pump Assy	1P801	Granger	1	0102	--	--									
2.1	Centrifigal Pump ▲						2	12.058	p. 30	▲12.058				5.0	▲60.29	p. 30	Pump Cent GND
2.2	Motor 3/4hp ▲						2	7.552	P. 28	▲7.552				2.0	▲15,104	p. 28	Motor, Fract hp AC GND MOB
1.3	Cylinder, Hyd ▲	Projectile Saw	R2K	Hydro-line	1	0103	2	15.228	p. 15	▲15.228				4.0	▲60.912	p. 15	Act, Lin Hyd GND
1.4	Cylinder, Hyd ▲	Projectile Saw Jaw	36	Hannifin	1	0201	2	15.228	p. 15	▲15.228				4.0	▲60.912	p. 15	Act. Lin Hyd GND
1.5	Clevis, Rod		50942	Hannifin	1	0204	2	Neg.									
1.6	Pin, Pivot		68369	Hannifin	1	0205	2	Neg.									
1.7	Cylinder, Hyd ▲	Projectile Saw Jaw	C3L-1-4	Hannifin	1	0218	2	15.228	P. 15	▲15.228				4.0	▲60.912	p. 15	Act, Lin Hyd GND
1.8	Bearing, Teflon ▲	Saw Vise	P1620-5	Boston	2	0405	2	2.059	P. 16	▲4.118				2.0	▲8.236	p. 16	Bearing, Gen, GND
1.9	Valve Hyd, Pres Reduc. ▲		PR60051	Manatrol	1	1101	2	8.416	p. 43	▲8.416				3.0	▲25.248	p. 43	Valve, Hyd Pres Reg GND MOB
.10	Gage		115	Marsh	1	1102	3										
.11	Hose ▲		421-8	Hannifin	12 ft	1116	2	.240	p. 24	▲.240				2.0	▲.48	p. 24	Hose GND MOB
.12	Blade ▲		421-8		1	1901/02	2	.200	*	▲.200				2.0	▲.400	*	
.13	Valve Ball ▲	Coolant			1		2	1.441	p. 41	▲1.441				3.0	▲4.323	p. 41	Valve, Ball GND MOB Not used at TEAD
***	See Sheet No. 4																
2.0		Supplemental Charge Remover															
2.1	Cylinder Hyd ▲		1 1/5HHBX 04CC	Sheffer	1	1209	2	15.228	p. 15	▲15.228				4.0	▲60.912	p. 15	Act Lin Hyd GND
2.2	Cylinder, Hyd ▲		1 1-2HHTF 2 1/8CC	Sheffer	1	1210	2	15.228	p. 15	▲15.228				4.0	▲60.912	p. 15	Act Lin Hyd GND
2.3	Bearing Sleeve ▲		P1014-8	Boston	4	1212	2	2.059	p. 16	▲8.236				2.0	▲16.472	p. 16	Bearing, Gen GND
2.4	Bearing, Sleeve ▲		FP1014-8	Boston	2	1213	2	2.059	p. 16	▲4.118				2.0	▲8.236	p. 16	Bearing, Gen GND
2.5	Bearing, Sleeve ▲		FP1014-8	Boston	2	1214	2	2.059	p. 16	▲4.118				2.0	▲8.236	p. 16	Bearing, Gen GND
2.6	Magnet ▲		CE3/4	Shrader	8	1303	2	Neg.									
2.7	Hose ▲		421	Hannifin	12 ft	1806	2	.240	0. 24	▲.240				2.0	▲.480	p. 24	Hose GND MOB

*Information is detailed in Supplemental Data Sheet

**Failure Consequence Code

1 - Catastrophic Failure
2 - Production Line Shutdown Failure
3 - Minor Failure - Repair During Maintenance Period
4 - See Supplemental Data Sheet

▲ CYCLE ITEM

ITEM 1 ▲ $\Sigma N\lambda$ = 292.441 x 10^{-6}/HR

ITEM 2 ▲ $\Sigma N\lambda$ = 47.168 x 10^{-6}

$$MTBF = \frac{1}{\Sigma N\lambda} = \frac{1}{\_\_\_\_} = \_\_\_\_ \text{ HRS}$$

ITEM 1 ▲ $\Sigma N\lambda TM$ = 735.213 x 10^{-6}

ITEM 2 ▲ $\Sigma N\lambda TM$ = 155.248 x 10^{-6}

$$MTTR = \frac{\Sigma N\lambda TM}{\Sigma N\lambda} = \_\_\_\_ = \_\_\_\_ \text{ HRS}$$

$$AVAILABILITY = \frac{1}{1 + \frac{MTTR}{MTBF}} \times 100\% = \_\_\_\_ \%$$

Figure 5-4 Equipment Information and Failure/Maintainability Data

Part No. MFGR Code	:These are included to identify the component and permit traceability to the source of the hardware.
Quantity (N)	:Number of items involved.
Information Source	: (XXX) Drawing series of the building block XX Drawing number of above drawing series (i.e. 504-23) where item is defined. XXX Drawing number of above drawing series and part number on the drawing (i.e., 504-2301). XX/XX Drawings showing item. The source drawings and their dates are listed as part of the supplemental information. Additional drawings on aperture cards were reviewed and judged to contain only structural non-functional items with negligibl failure rates. These items were not included because of their minor impact on the system availability. When no source is listed, the data were obtained from the draft demil plan or sketches and information from TEAD personnel.

Failure consequences listed in this column were defined as follows:

1 - Catastrophic failure of the system.

2.- Production line shutdown failure - requires stoppage of normal production and repair (remove and replace) prior to restoring production.

3 - Minor failure - repair during maintenance period or repair without interrupting normal production. The design of the system was not reviewed to establish if the system could "overdrive" a component failure.

Where the failure consequence was judged to be of a nature that the item could be repaired during normal production or during a scheduled shutdown, analysis was stopped at that point (i.e., failure consequence code 3).

Rate λ ($\times 10^{-6}$ hr) : Failure rate in number of failure $\times 10^{-6}$ per N hr. The assigned failure rates assume that the items receive routine maintenance including diagnostic testing and adjustments and are those projected rates between the initial "infant" mortality and normal wearout periods.

When data were available in terms of failures per 10^{-6} hours, they were used in preference to the data expressed on number of failures per cycle. When cyclic data were used, they were standardized at 10 cycles per hour.

When information used was derived from airborne *applications, the rates were divided by 6.5* to adjust the failure rate to ground conditions. All failure rate data indicated are shown as 10 cycles per hour. Adjustment to applied production rates is done after compilation of Nλ.

NEG - Judged to have a negligible failure rate in relationship to other items listed in the same item grouping.

Source : *Refer to Supplemental Data Sheet

PXX Page Number Report, RADC-TR-69-458, Section 2, modified by RADC-TR-74-268, October 1974.

EST Assigned value based on judgement.

Nλ : The number of items multiplied by the failure rate.

Diagnostic Time (hr) : Time required to establish that the item has failed and needs to be repaired.

Repair Time (hr) : Time required to repair/replace item including obtaining item from spare stock.

Checkout Time (hr) : Time required to checkout repair and be ready to restart production operations.

Total Maintenance Time (TM) (hr)	:	Total time involving all above times. As discussed (Paragraph 5.1.2) a minimum of two (2) hours was used as a conservative total maintenance time for unscheduled maintenance activities.
NλTM (X10^{-6})	:	The number of items multiplied by the failure rate multiplied by the total repair time.

Spare parts were assumed to be available on site to replace failed equipment on the shortest turn around time - examples: 1) printed circuit board cards for the control system, 2) cameras for the CTV system, 3) ratio motor assembly for conveyors, 4) rollers with bearings for conveyors.

Trained maintenance personnel and documentation of the equipment configuration and manuals were assumed to be on site during all production operations.

Maintenance times for equipment inside the ECC assumed the presence of a hoist inside the ECC at all times.

Source : See supplemental sheets for information.

PXX Page number of work book RADC-TR-69-458, Section 2 modified by RADC-TR-74-268, October, 1974, or RADC-TOR-64-373 Volumes I and II.

EST Assigned value based on judgement. The workbook was developed to establish repair times. Selected data from RADC-TOR-64-373 Volumes I and II and repair times estimates were documented in the workbook.

Remarks : Title of item used in the RADC reports. Additional notes and justification of failure rates and total maintenance time.

The results of calculations for MTBF, MTTR and availability are included on the data forms as in example Figure 5-5, Building Block Availability Parameter Summary, and Figure 5-6, Munition Availability Parameter Summary.

Figure 5-5. Building Block Availability Parameter Summary

BUILDING BLOCK: #1 UNPACK AREA (UPA)

MUNITION	AGENT	EXP.	PROP.	Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
*M55 ROCKET,GB/VX								
Rocket, 115mm, M55	GB	Comp B	M28	NEG.	N/A	NEG.	N/A	≈1.0
Rocket, 115mm, M55	VX	Comp B	M28	NEG	N/A	NEG.	N/A	≈1.0
*PROJECTILES/ CARTRIDGES, GB/VX WITHOUT BURSTERS								
Cartridge, 105mm, M360	GB	None	None	NEG.	N/A	NEG.	N/A	≈1.0
Projectile, 155mm, M121A1	GB	None	None	241.039	4149	584.843	2.43	.9994
Projectile, 155mm, M121	GB	None	None	241.039	4149	584.843	2.43	.9994
Projectile, 155mm, M122	GB	None	None	241.039	4149	584.843	2.43	.9994
Projectile, 8", M426	GB	None	None	153.506	6514	371.708	2.42	.9996
Projectile, 155mm, M121A1	VX	None	None	241.039	4149	584.843	2.43	.9994
*P/C,GB/VX WITH BURSTERS								
Cartridge, 105mm, M360	GB	Tetrytol	M1	NEG.	N/A	NEG.	N/A	≈1.0
*PROJECTILES,MUSTARD WITH BURSTERS								
Projectile, 155mm, M110	H	Tetrytol	None	241.039	4149	584.843	2.43	.9994
Projectile, 155mm, M104	HD	Tetrytol	None	241.039	4149	584.843	2.43	.9994
*M23 MINE, VX								
Mine, 2 gallon,M23	VX	Comp B	None	NEG.	N/A	NEG.	N/A	≈1.0
*4.2" MORTAR, MUSTARD								
Cartridge,Mortar, 4.2",M2/M2A1	HD	Tetryl	M6	NEG	N/A	NEG.	N/A	≈1.0
Cartridge,Mortar, 4.2",M2/M2A1	HT	Tetryl	M6	NEG.	N/A	NEG.	N/A	≈1.0

*MUNITION DEMILITARIZATION PROCESS FLOW

Figure 5-5. (Continued) Building Block Availability Parameter Summary

BUILDING BLOCK:

MUNITION	AGENT	EXP.	PROP.	Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
*BULK ITEMS,GB/VX								
Bomb,750#,MC-1	GB	None	None	N/A	N/A	N/A	N/A	N/A
Tank,Spray, TMU-28/B	VX	None	None	N/A	N/A	N/A	N/A	N/A
Ton Container	GB	None	None	N/A	N/A	N/A	N/A	N/A
Tone Container	VX	None	None	N/A	N/A	N/A	N/A	N/A
*TON CONTAINER,MUSTARD								
Ton Container	HD	None	None	N/A	N/A	N/A	N/A	N/A

*MUNITION DEMILITARIZATION PROCESS FLOW

Figure 5-6 Munition Availability Parameter Summary

MUNITION DEMILITARIZATION PROCESS FLOW: M55 ROCKET, GB/VX

MUNITION: Rocket, 115mm, M55 Agent: VX Exp: Comp B Prop: M28 Process Rate: 20/hr

NO.	ABV.	BUILDING BLOCK	Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NEG	N/A	NEG	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	510.128	1960	6125.587	12.01	0.9939
4.	DFS	DEACTIVATION FURNACE SYSTEM	2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE NA	-	-			
6.	RDM	ROCKET DEMIL MACHINE	2654.534	377	32662.332	12.30	0.9684
7.	DUN	DUNNAGE INCINERATOR SYSTEM NC		-			
8.	UTL	UTILITIES	NEG	N/A	NEG	N/A	≈1.0
9.	EHM	ECC HYDRAULICS	1836.106	545	18514.839	10.08	0.9818
10.	CON	CONTROL MODULE NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX NC					
13.	ADS	AGENT DESTRUCTION SYSTEM	4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	393.9	2539	2246.8	5.70	0.9978
15.	PDM	PPOJECTILE DEMIL MACHINE NA	-				
8.	PPD	PROJECTILE PULL AND DRAIN MACHINE NA	-				
19.	CDS	CENTRAL DECON SYSTEM	256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY NC	-				
21.	BIF	BULK ITEM FACILITY NA	-				
22.	MHE	MATERIAL HANDLING EQUIPMENT	4601.758	217	53437.995	11.61	0.9493
23.	FIL	FILTER SYSTEM	636.5	1571	4512.6	7.09	0.9955
24.	MOR	MORTAR DEMIL MACHINE NA	-				
25.	MIN	MINE DEMIL MACHINE NA	-				
26.	PIP	PIPING	50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL	509.916	1961	1031.496	7.02	0.9979
28.	MOD	SCALE MODEL NC	-				
29.	PER	PERIMETER MONITORING NC	-				
30.	CTV	CLOSED CIRCUIT TELEVISION	114.155	8760	229.31	2.0	0.9997
31.	COM	COMMUNICATIONS	365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY NC	-				
33.	DET	DETECTORS NC	-				
34.	TDP	TECHNICAL DATA PACKAGE NC	-				
35.	SCS	SITE CONTROL SYSTEM	2782.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING NC					
37.	RAM	REPAIR & MAINTENANCE NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT NC					
41.	SYS	SYSTEM INTEGRATION NC					
		TOTAL MUNITION PROCESS	22001.8	45.5	180558.6	8.2	0.8473

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

5.2.2 Reliability Data

5.2.2.1 Reliability Basis

The reliability effort for this task phase has been based on the procedures set forth in the Military Standard for Reliability Predictions, MIL-STD-756A (Reference (10) and the definitions set forth in Section 3.4 herein. Some of the basic reliability prediction procedures set forth in MIL-STD-756A include:

- Define the product (components, assemblies, building blocks, etc.)
- Establish the reliability model
- Determine the part population for each functional block
- Determine appropriate stress factors for each part
- Assign applicable failure rate to each part
- Compute reliability for each functional block
- Compute reliability for the product.

A conscious effort has been made throughout this task to assure that these procedures were applied in the most appropriate manner to obtain the most valid results possible.

5.2.2.2 Basic Reliability Equation

The general definition of reliability as stated in Section 3.4 is:

Reliability is the probability that an item subassembly, assembly, or system will perform its intended function for a specified interval under stated conditions.

This definition as applied to CAMDS in this analysis is:

The reliability of a CAMDS munition demilitarization processes is the probability that all components, subassemblies, assemblies, and building blocks necessary to complete the process (also includes any failures whose occurrence would abort the process whether necessary to complete the process or not) will perform their intended function for a specified interval (hours and/or units processed (cycles)) under stated conditions.

There are many equations that have been developed to express the numerical reliability of a hardware element (component, subassembly, assembly, etc.) depending on its relationship with other hardware elements. These include (but are not limited to) series, parallel, and standby equations with variations within each (Reference (11)). Of these, the series equation is the most straight forward. The series equation applies when there is only one way that a given function in a process can be accomplished (i.e., A M55 rocket must enter the ECC and be sawed there by the RDM. There is no other way to accomplish this task in the present design). The CAMDS munition demilitarization process flows are almost exclusively a series concept. There are few instances either by design or by happenstance by which a given function can be accomplished in more than one way. One exception is in the Utilities Building Block where redundant boilers, air compressors, etc., exist. These exceptions are minute when compared with the total system. Considering the definition of CAMDS reliability and the lack of redundancy in the system by design, it was determined that little inaccuracy would be introduced in the results by modeling each of the munition demilitarization process flows exclusively as a series concept. In conducting the analysis, this was facilitated by applying the following failure consequence code definition:

Failure Consequence Code:

1) Catastrophic Failure (If existing, the failure rate of this type of failure would be summed into the series reliability equation. The previous task completed in this contract (Reference (12)) shows that no Catastrophic Failures exist in CAMDS).

2) Production Line Shutdown Failure (since CAMDS is a series system by design most of the failures fall into this category and their failure rates are summed into the series equation).

3) Minor Failure-Repair During Maintenance Period [Any failure that would not result in the immediate shutdown of the process line for repair falls into this category. This includes "nuisance" failures and failures in units where ready redundancy is available (such as redundant air compressor, etc.). These failure rates would not be summed into the series equation.]

The series reliability equation used in this analysis to calculate the probability of success for a CAMDS munition demilitarization process (R_p) is (Reference (11):

$$R_p = \pi R_{BB}$$

Where $R_{BB} = e^{-\lambda_{BB} t}$ = the estimated reliability of a building block necessary for the success of a given demil process.

λ_{BB} = the series failure rate for a given building block in $F/10^6$ hrs.

t = an element of time in hours.

When all R_{BB}'s in the process are exponential (which, as is customary, has been assumed in this analysis) and in series, the equation for R_p is:

$$R_p = e^{-[\Sigma(\lambda_{BB})xt]}$$

This equation for reliability was used consistently in this analysis.

5.2.2.3 Reliability Data Base

The reliability data used in this task phase were recognized as a critical element to the validity of the results obtained in all subsequent phases of the total task. The most appropriate reliability data sources to realistically model the actual CAMDS system were considered to be, in order of preference:

- Data obtained from CAMDS testing
- Data obtained from RMA operations
- Data recorded under a controlled program and subjected to CAMDS applicability criteria
- Generic data judged to be applicable
- Engineering judgments.

While data obtained from CAMDS testing would most realistically model the CAMDS system (other than data obtained from actual CAMDS operations), it is currently limited in quantity and will be available only "after the fact" for this effort. Data were available from RMA operations, but they were also limited in quantity because the computerized documentation system contains only data generated since February 1975 at the present time. An additional constraint was that the data were most readily available at the "subsystem major component" level (i.e., Versatran - 8203 Head, 8209 Flapper, 8213 Programmer, 8214 general, e and not to the component level which would have been most desirable for this analysis. Component level data were stated to be available on an individual item request basis. No such data were made available for this analysis. Since the two most appropriate reliability data sources proved to be unavailable or excessively restrictive, TRW concentrated efforts on obtaining data from the third most appropriate source (data recorded under a controlled program and subjected to CAMDS applicability criteria) and used data from the two prime sources as supplement as they became available. Generic data and engineering judgments were used only when the three best sources were not sufficient.

The most extensive and applicable reliability data source found was published by Rome Air Development Center (RADC) in Reference (13). These data were gathered processed by the Martin Marietta Aerospace Corporation under contract to the government. The data were from a wide variety of base sources. The data have several advantages:

- Data were gathered and processed under a controlled system by controlled procedures.
- Data are current and represent a relatively large effort [contract period 2-73 to 6-74 (17 months) and lists approximately a dozen individuals as major contributors.]
- Data are large in quantity.
- Data contain many components generically similar to CAMDS components.
- Statistical data analysis procedures were applied to the data:

  Assumption of Exponential Distribution
  Calculation of Confidence Limits
  Test of Homogeneity of Data (i.e., identified and omitted "outlier data points")
  Statistical Test for the Equality of Two Life Distributions

- Data results failing to satisfy certain criteria relative to suitability were excluded or synthesized.

The data have one major disadvantage:

- The component failure rates are for the most part presented in terms of F/hours with only a limited number in terms of F/cycles.

5.2.2.4 Reliability Data Factors

Recognizing the limitations of the failure rate data source, it was determined to be realistic and desirable to attempt to factor the base data to account for these limitations. The most obvious limitation of the data base relative to the CAMDS application is that the data base is predominately in terms of failure/10^6 hours while the CAMDS application utilizes many components on a varying cyclic rate depending on the munition being demilitarized. Thus, the failure rate in terms of failures/10^6 hours does not differentiate between a known cyclic dependent component (i.e., valve, actuator, etc.) that cycles 20 times per hour when processing M55 Rockets, but cycles 50 times per hour when processing 105 MM Cartridges. To avoid estimating the same component probability of success for widely differing cyclic applications such as this, the following failure rate factors were developed:

Failure Rate Factors - High Cyclic Application

	Target Munition Processing Rate (Day)	Target Munition Processing Rate (HR)	Failure Rate Factor
Condition A (Base)	N/A	N/A	1 (Base)
Condition 1	400	20	2
Condition 2	650	32.5	3.25
Condition 3	800	40	4
Condition 4	1000	50	5

The rationale for determining these factors was as follows:

- The RADC failure rate data though expressed in terms of Failures/10^6 hours reflects many components whose failure characteristics are cycle dependent.
- The RADC time dependent failure rates reflect a certain mean number of cycles depending on the application from which they were derived.

- The actual number of cycles per hour represented for a given component is not known exactly. However, while it is not known exactly what type systems all the data were derived from, some are known, and it is almost certain that the majority were not high cycle rate applications (i.e., such as canning factory machinery, etc.).

- If the mean number of cycles represented by a component's time dependent failure rate is estimated too high and applied, the results of this analysis will not be conservative. If the mean is estimated too low, the results of the analysis will be too conservative. If given a preference, the error should be on the side of being slightly conservative.

- It was estimated, based on what was known of the data sources, that a realistic mean cycle application basis for the time dependent recorded failure rate data is 10 cycles/hour.

- Therefore, for components whose failure rates were determined to be cyclic sensitive and which are also subjected to a large number of application cycles (above the mean of 10 per hour), the given factors were applied. For example:

  Base Failure Rate:

  $15.228F/10^6$ hrs = RADC actuator failure rate

  Factors Applied:

  $1 \times 15.228 = 15.228\ F/10^6$ hrs = ECC personnel door actuator (low cyclic application case)

  $2 \times 15.228 = 30.456\ F/10^6$ hrs = ECC munition door actuator (M55 Rocket processing)

  $3.25 \times 15.228 = 49.491\ F/10^6$ hrs = ECC munition door actuator (155 MM Projectile processing)

  $4 \times 15.228 = 60.912\ F/10^6$ hrs = ECC munition door actuator (M23 Mine processing)

  $5 \times 15.228 = 76.125\ F/10^6$ hrs = ECC munition door actuator (105 MM Projectile processing)

  These high cyclic application failure rate factors were used consistently in this analysis.

5.2.2.5 Reliability Logic Diagrams

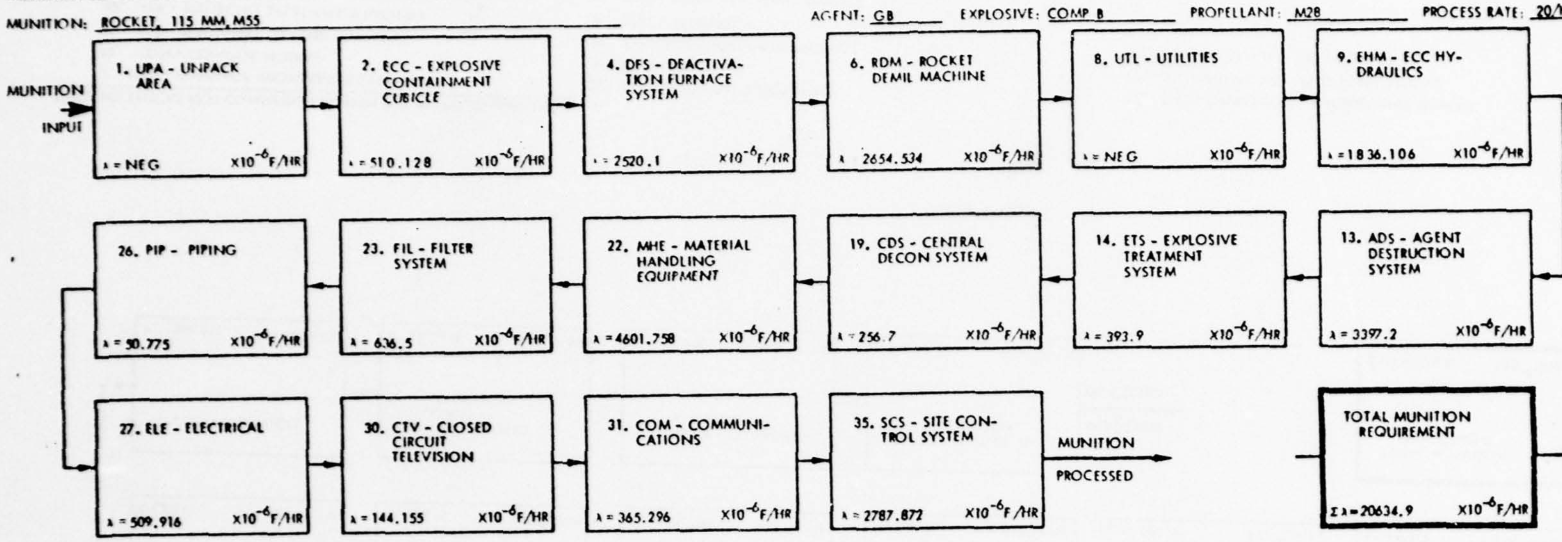
The following building block level Reliability Logic Diagrams have been constructed for each type of processed munition. All building blocks which are utilized in the processing procedure for the particular munition type are included in the network along with their calculated system failure rates. These logic diagrams are reflective of the in-line (series) CAMDS design. The summation of the building block failure rates is identified as the Total Munition Requirement. Building blocks not considered in the overall analyses by agreement and those which are excluded from a given network by design are identified as such by line entries at the bottom of the diagram.

The "mission" times, utilized with the Total Munition Requirement failure rate, in determination of reliability levels per the basic reliability equation (Section 5.2.2.2) are as noted in Section 5.2.4.1. The logic diagrams presented herein must be considered along with the continuous operational processing time as indicated in Section 5.2.4.1 in determination of reliability levels of the processing function for each type munition.

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: M55 ROCKET, GB/VX

MUNITION: ROCKET, 115 MM, M55 AGENT: GB EXPLOSIVE: COMP B PROPELLANT: M28 PROCESS RATE: 20/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

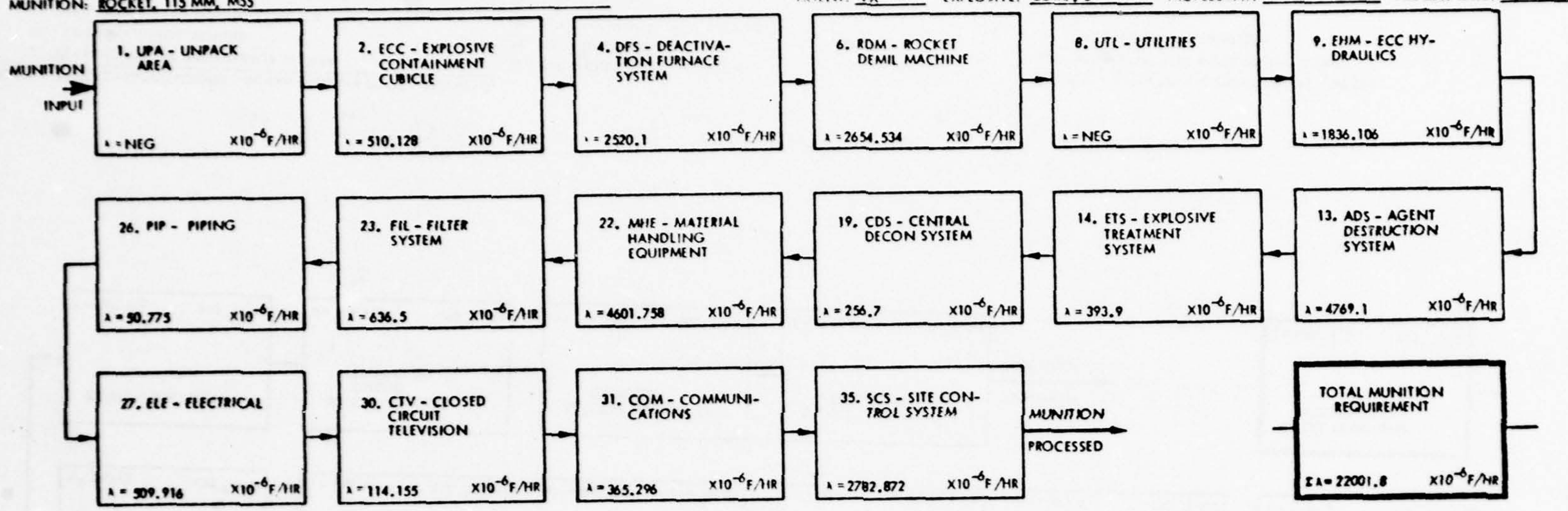
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

5. MPF - METAL PARTS FURNACE
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: M 55 ROCKET, GB/VX

MUNITION: ROCKET, 115 MM, M55 AGENT: VX EXPLOSIVE: COMP. B PROPELLANT: M28 PROCESS RATE: 20/HR



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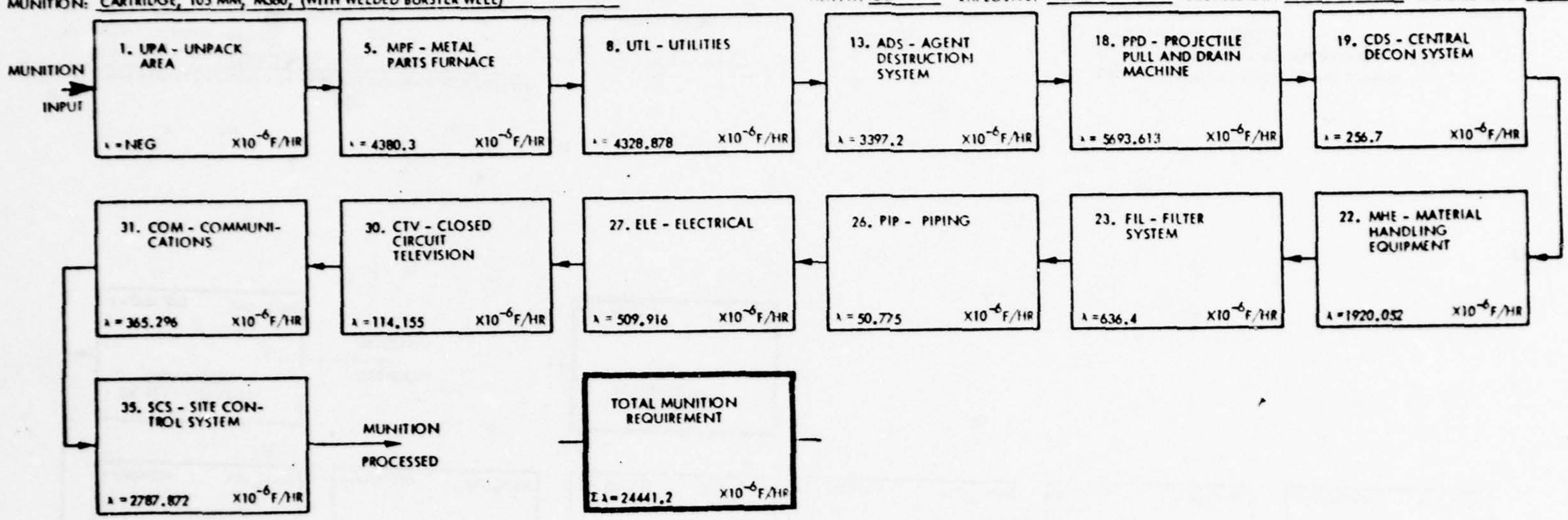
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTER

MUNITION: CARTRIDGE, 105 MM, M360, (WITH WELDED BURSTER WELL) AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 50/HR



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BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
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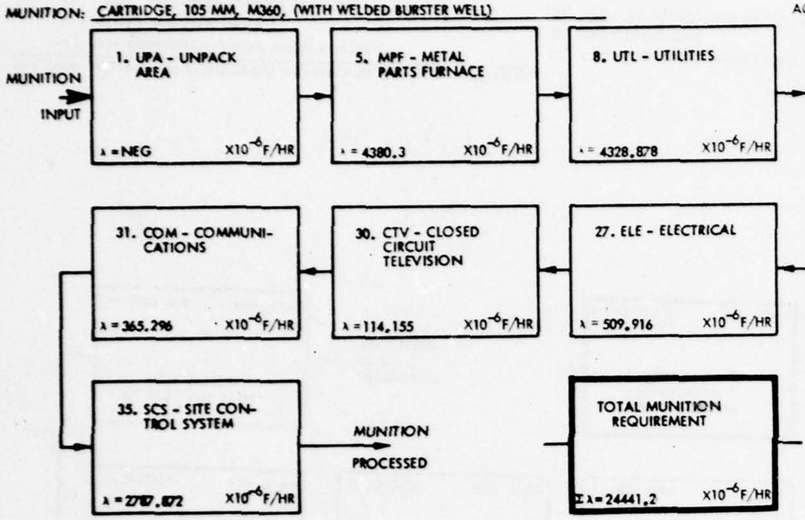
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTERS

MUNITION: CARTRIDGE, 105 MM, M360, (WITH WELDED BURSTER WELL) AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 50/HR



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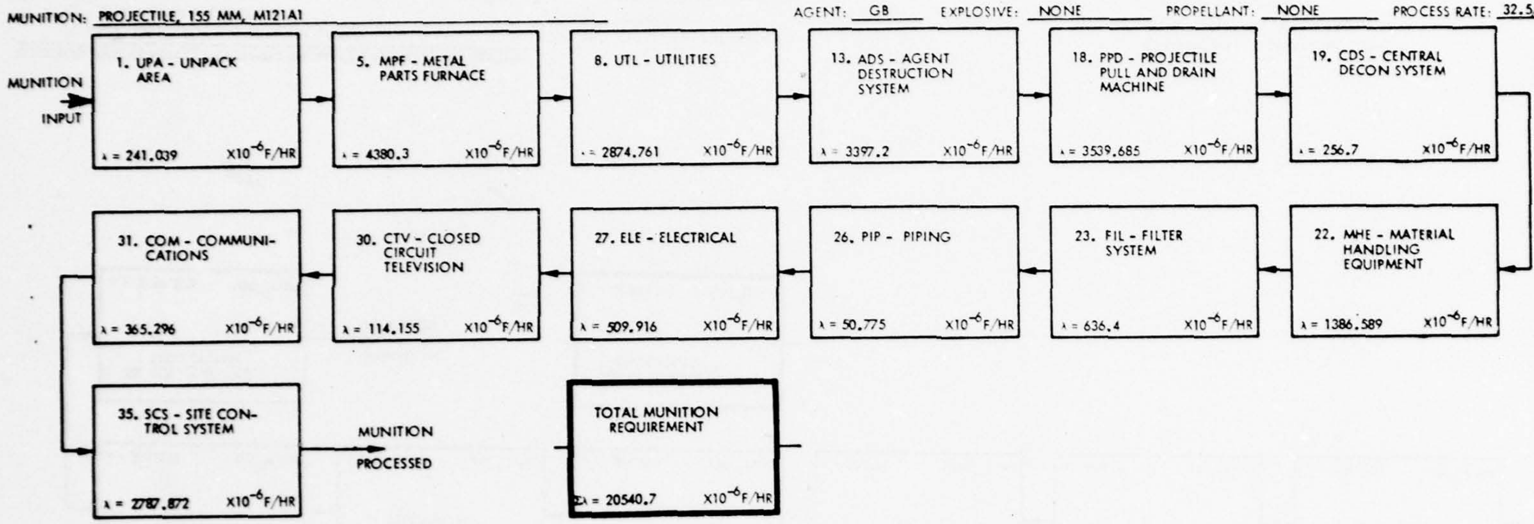
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE, 155 MM, M121A1 AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 32.5/HR



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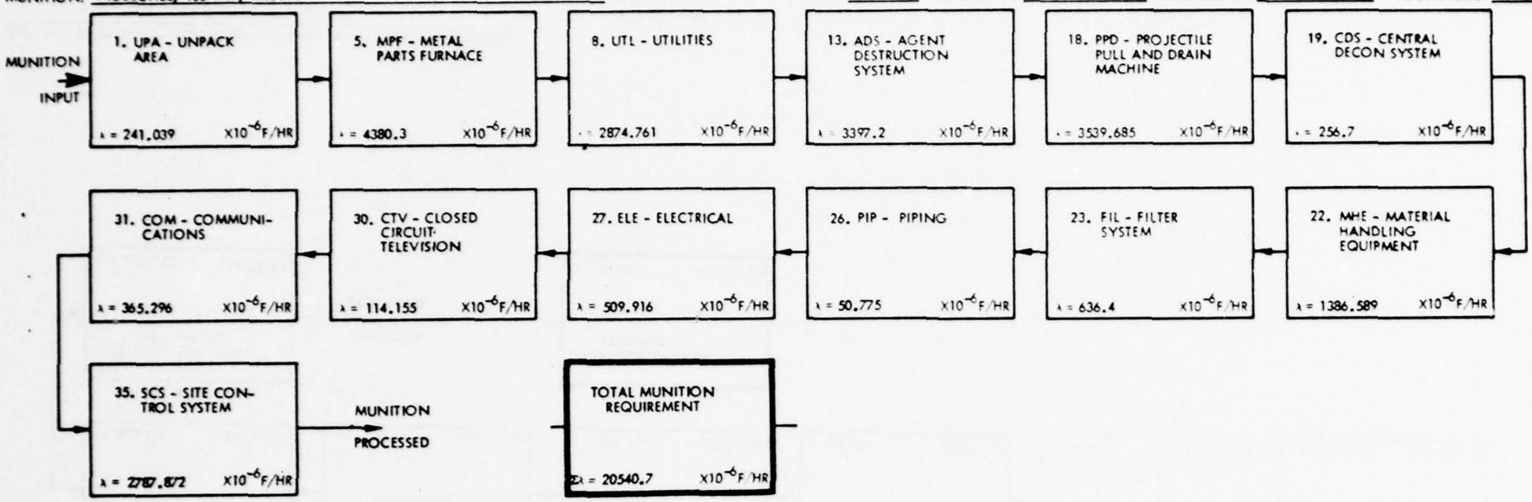
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE, 155 MM, M121A1 AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 32.5/HR



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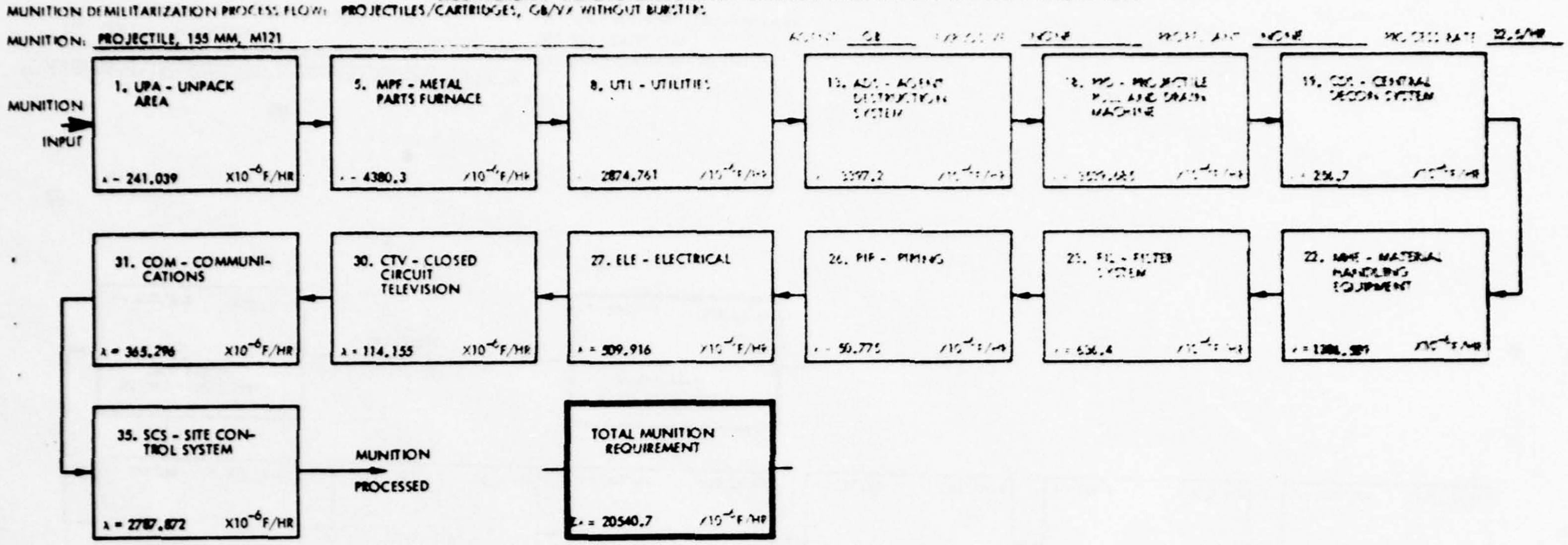
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE, 155 MM, M121



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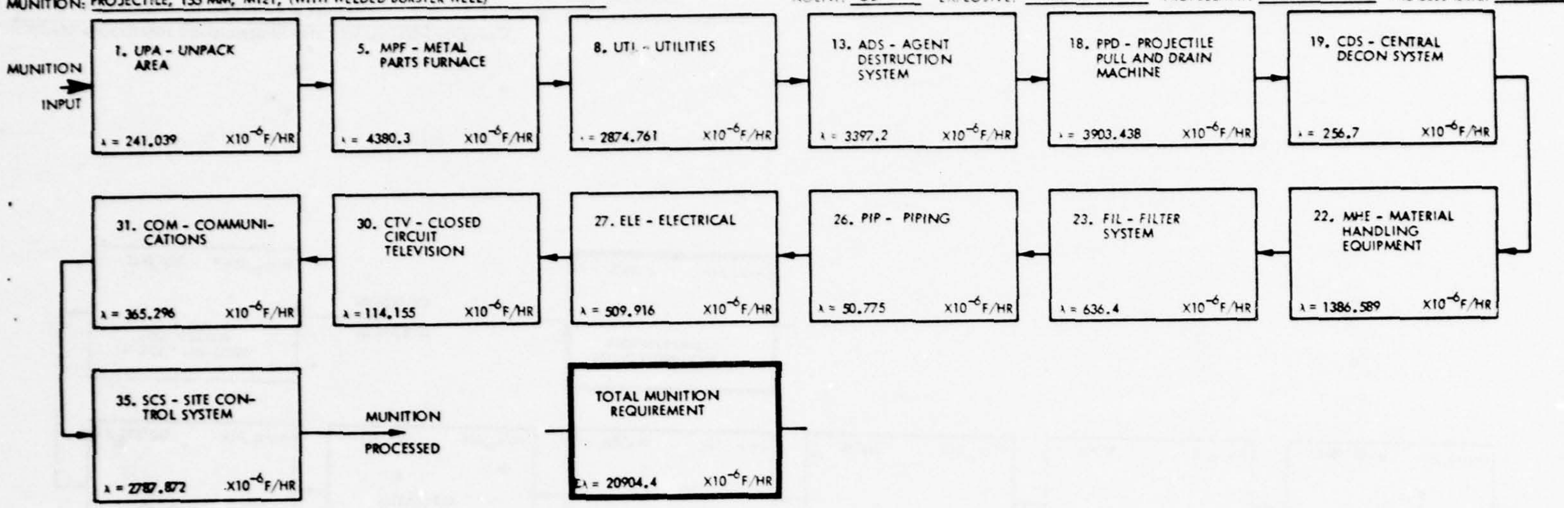
RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE, 155 MM, M121, (WITH WELDED BURSTER WELL) AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 32.5/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

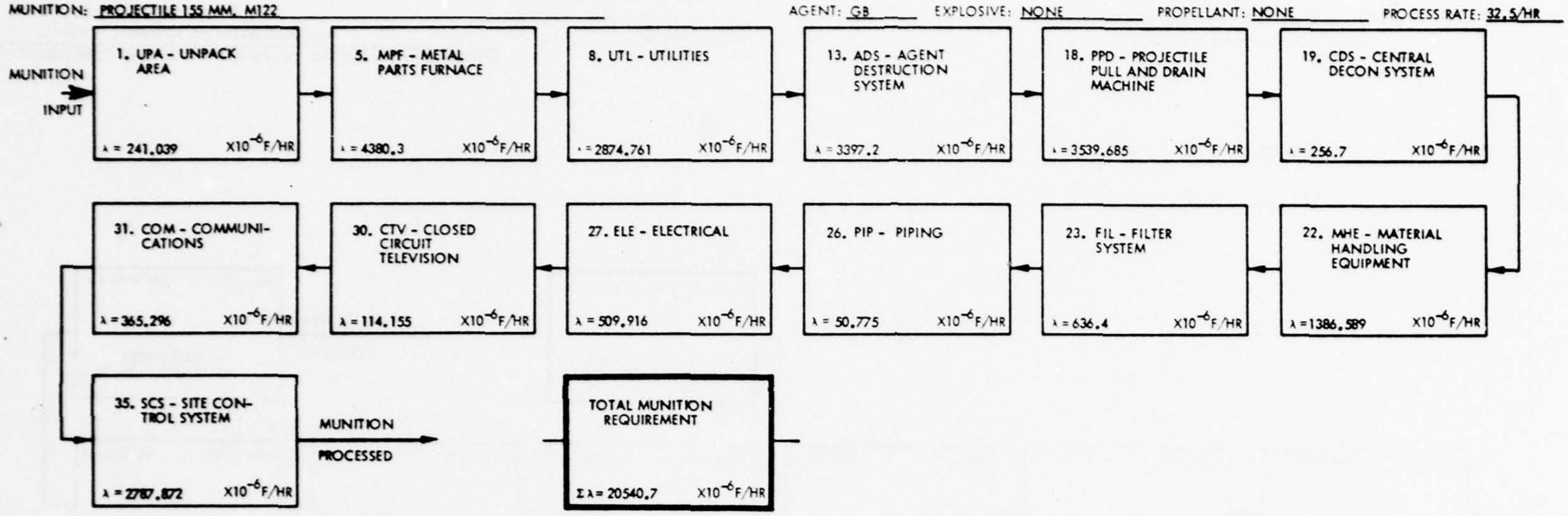
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
[illegible]. EHM - ECC HYDRAULICS
[illegible]. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE 155 MM, M122 AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 32.5/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

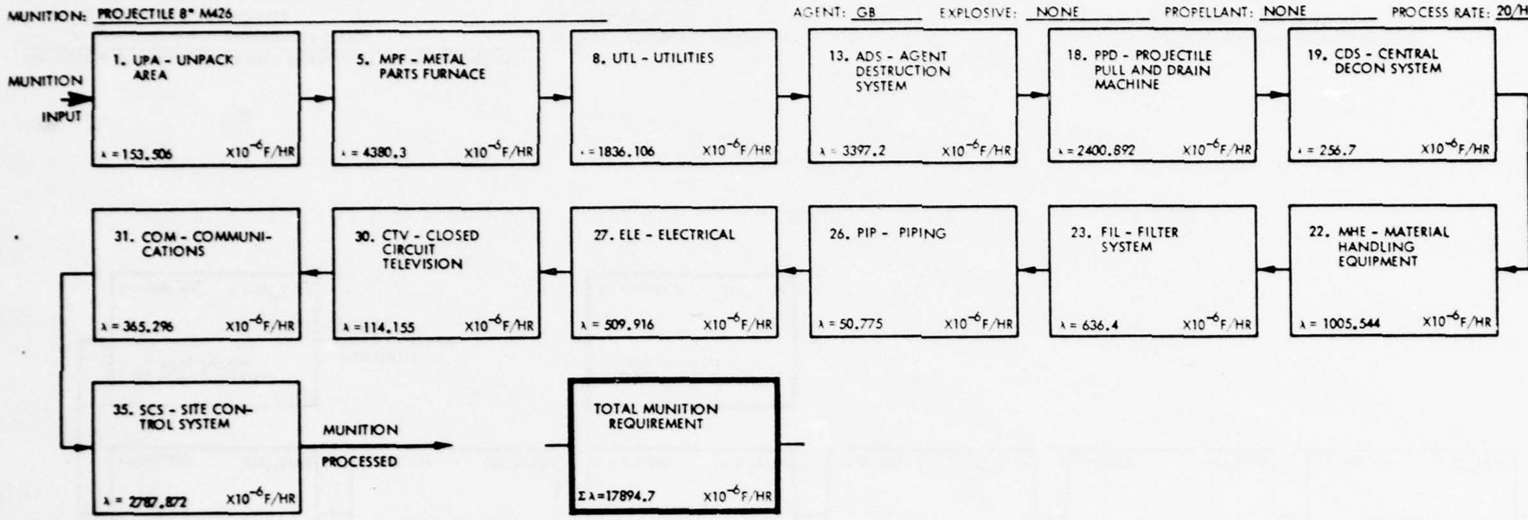
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE 8" M426 AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 20/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

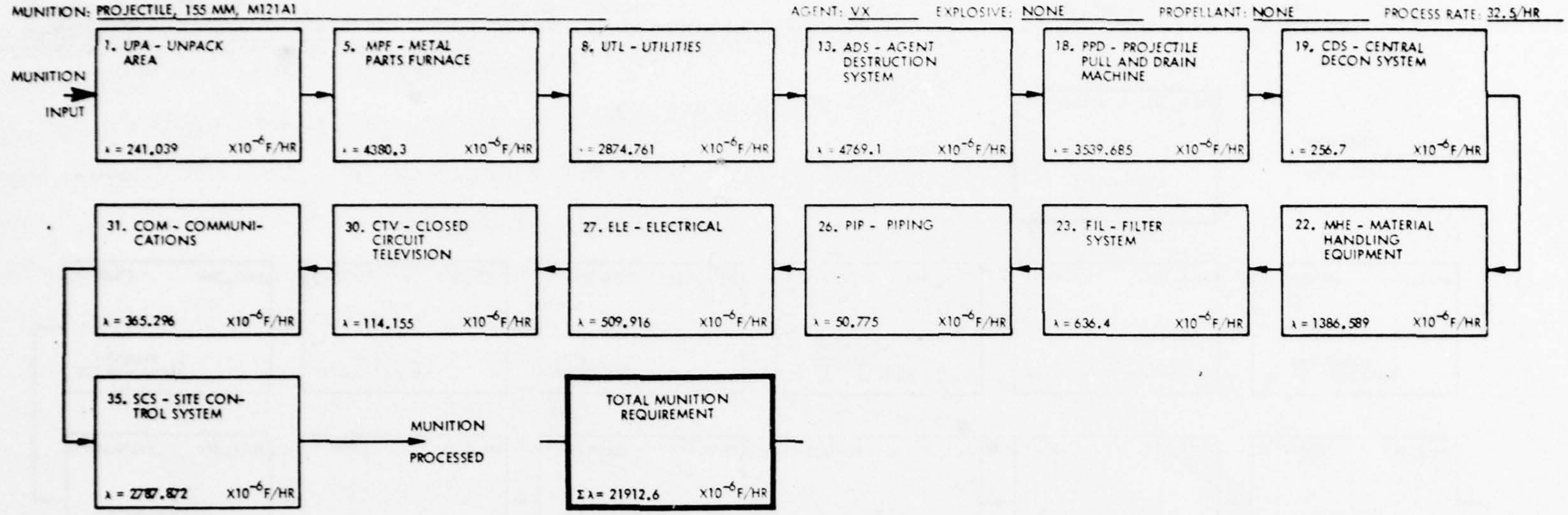
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
ETS - EXPLOSIVE TREATMENT SYSTEM
PDM - PROJECTILE DEMIL MACHINE
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: PROJECTILE, 155 MM, M121A1 AGENT: VX EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 32.5/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
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28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

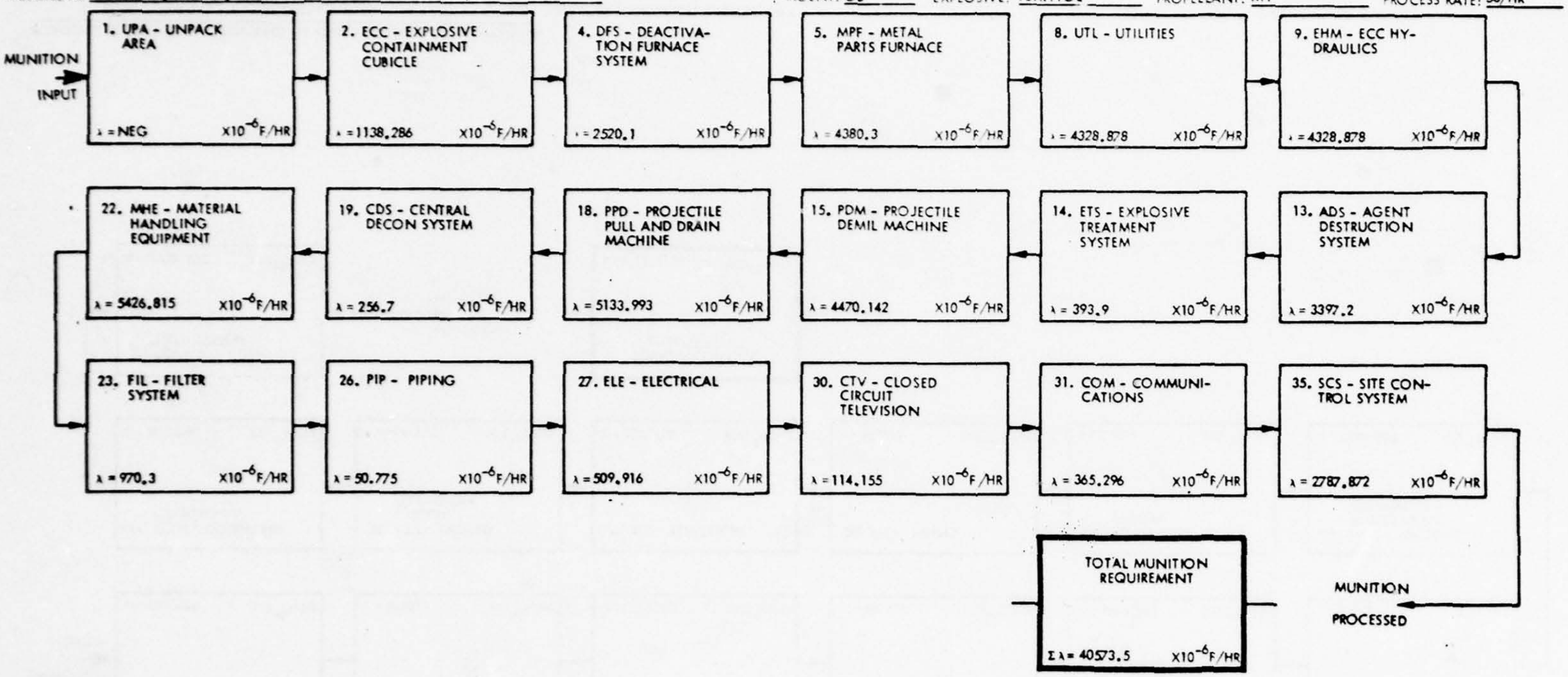
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARDTRIGES, GB/VX WITH BURSTERS

MUNITION: CARTRIDGE, 105 MM, M360 AGENT: GB EXPLOSIVE: TETRYTOL PROPELLANT: M1 PROCESS RATE: 50/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

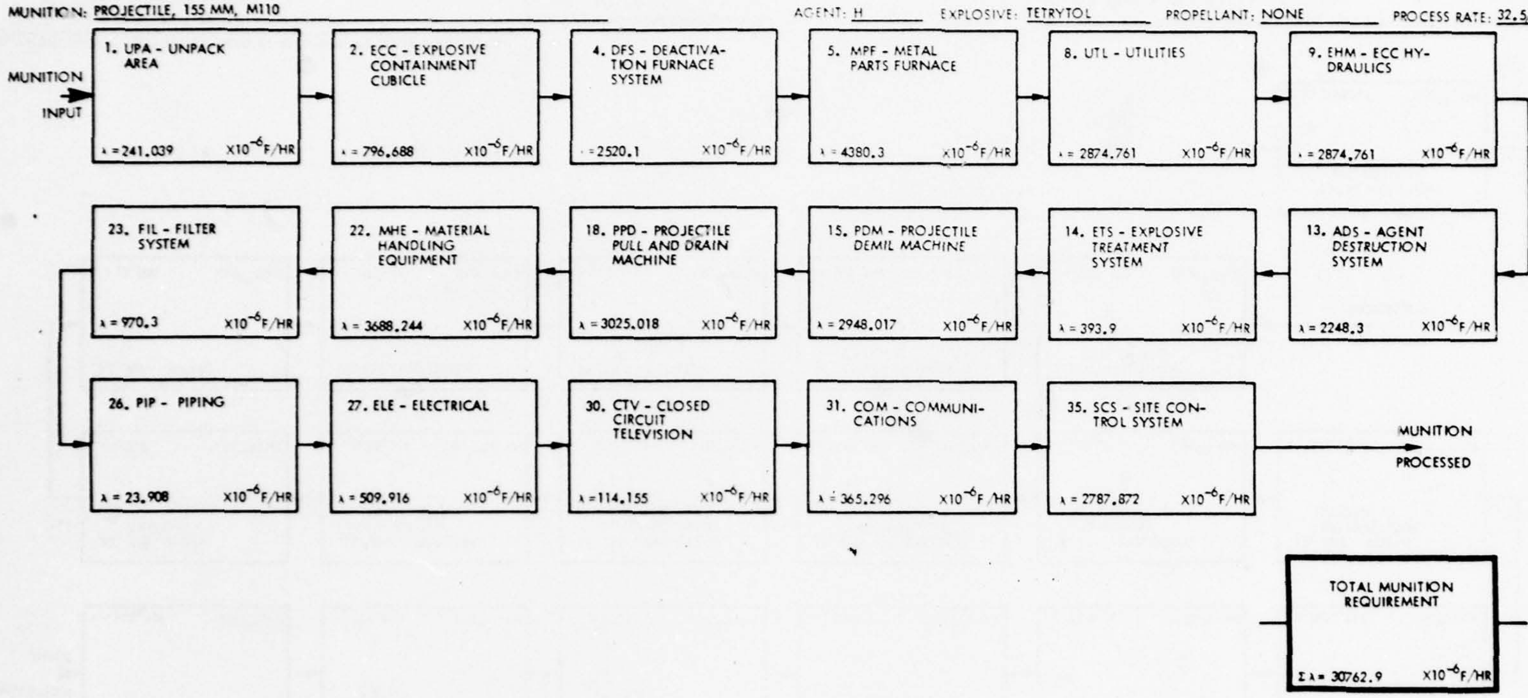
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

6. RDM - ROCKET DEMIL MACHINE
2'. BIF - BULK ITEM FACILITY
21. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES, MUSTARD WITH BURSTERS

MUNITION: PROJECTILE, 155 MM, M110 AGENT: H EXPLOSIVE: TETRYTOL PROPELLANT: NONE PROCESS RATE: 32.5/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

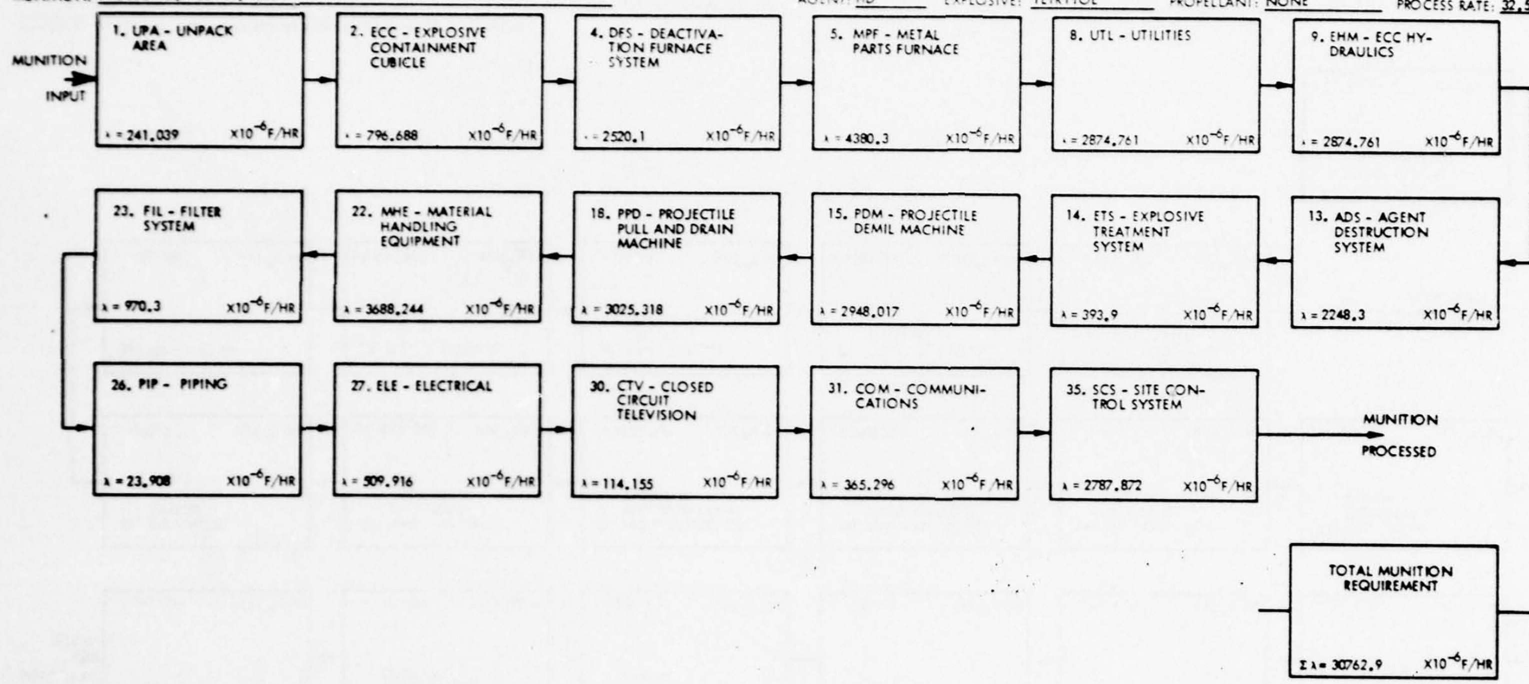
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

6. RDM - ROCKET DEMIL MACHINE
19. CDS - CENTRAL DECON SYSTEM
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES, MUSTARD WITH BURSTERS

MUNITION: PROJECTILE, 155 MM, M104 AGENT: HD EXPLOSIVE: TETRYTOL PROPELLANT: NONE PROCESS RATE: 32.5/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
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36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

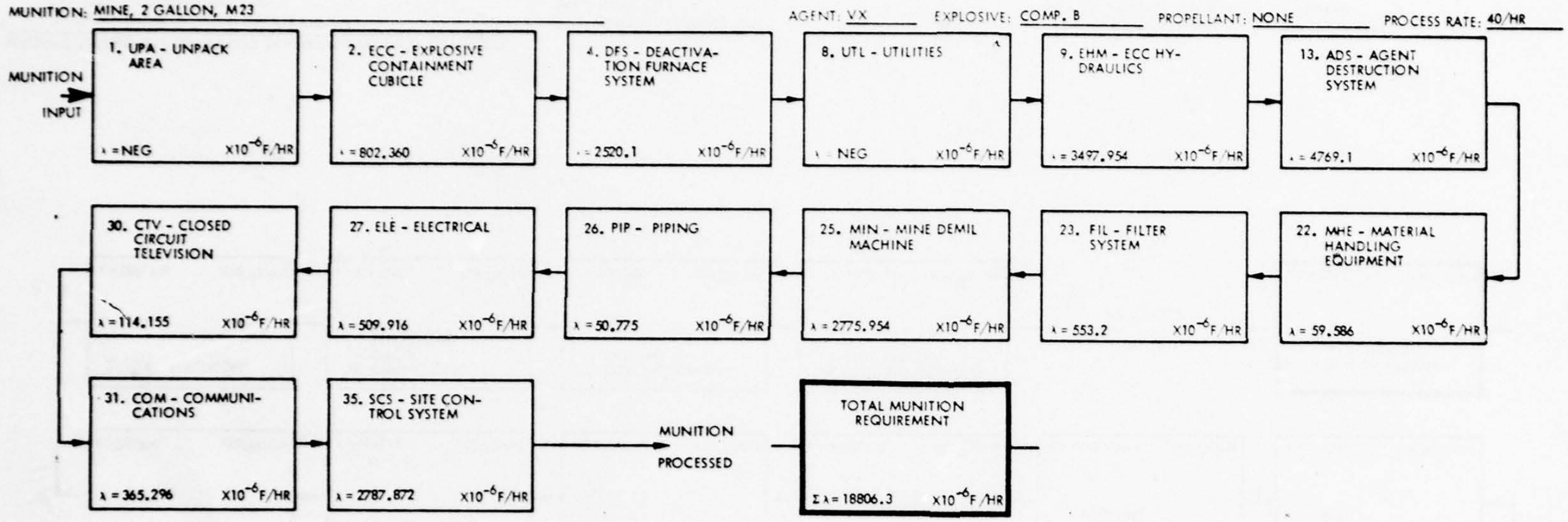
6. RDM - ROCKET DEMIL MACHINE
19. CDS - CENTRAL DECON SYSTEM
21. BIF - BULK ITEM FACILITY
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: M23 MINE, VX

MUNITION: MINE, 2 GALLON, M23

AGENT: VX EXPLOSIVE: COMP. B PROPELLANT: NONE PROCESS RATE: 40/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

- 7. DUN - DUNNAGE INCINERATOR SYSTEM
- 10. CON - CONTROL MODULE
- 12. PSC - PERSONNEL SUPPORT COMPLEX
- 20. PDF - PROJECTILE DISASSEMBLY FACILITY
- 28. MOD - SCALE MODEL
- 29. PER - PERIMETER MONITORING
- 32. CML - CHEMICAL LABORATORY
- 33. DET - DETECTORS
- 34. TDP - TECHNICAL DATA PACKAGE
- 36. TNG - TRAINING
- 37. RAM - REPAIR AND MAINTENANCE
- 38. SMP - SYSTEM MANAGEMENT AND PLANNING
- 39. OES - OPERATIONAL ENGINEERING SUPPORT
- 40. SIT - INITIAL TEST & SITE DEVELOPMENT
- 41. SYS - SYSTEM INTEGRATION

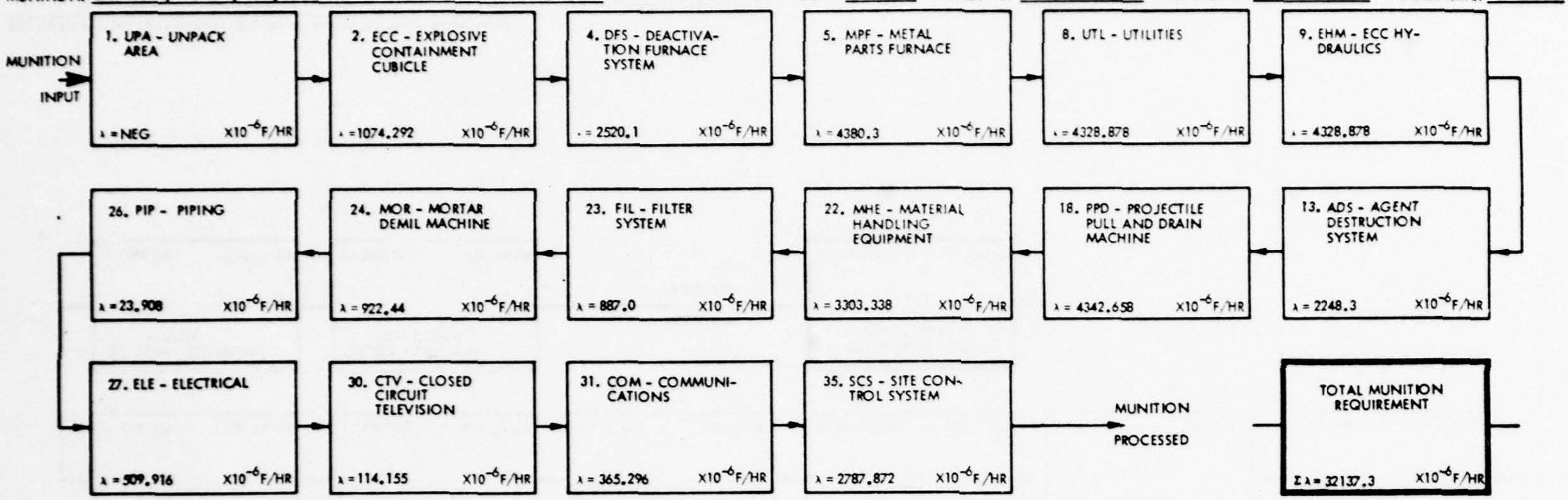
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

- 5. MPF - METAL PARTS FURNACE
- 6. RDM - ROCKET DEMIL MACHINE
- 14. ETS - EXPLOSIVE TREATMENT SYSTEM
- 15. PD.4 - PROJECTILE DEMIL MACHINE
- 18. PPD - PROJECTILE PULL AND DRAIN MACHINE
- 19. CDS - CENTRAL DECON SYSTEM
- 21. BIF - BULK ITEM FACILITY
- 24. MOR - MORTAR DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: 4.2" MORTAR, MUSTARD

MUNITION: CARTRIDGE, MORTAR, 4.2", M2/M2A1 AGENT: HD EXPLOSIVE: TETRYL PROPELLANT: M6 PROCESS RATE: 50/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

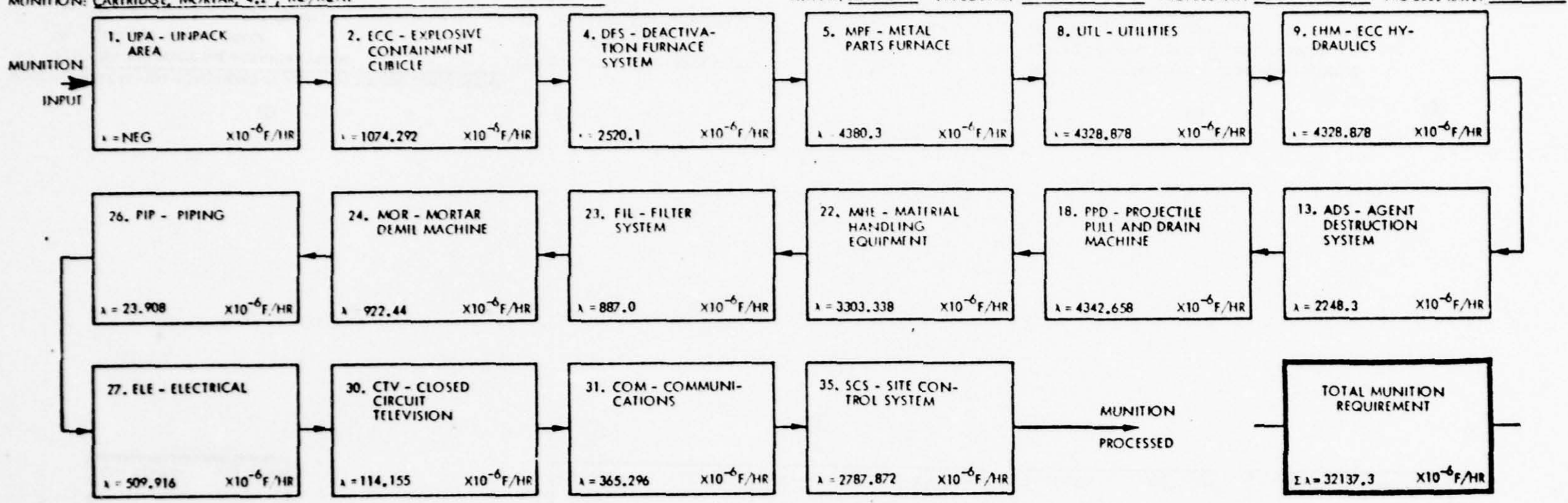
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

6. RDM - ROCKET DEMIL MACHINE
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
19. CDS - CENTRAL DECON SYSTEM
21. BIF - BULK ITEM FACILITY
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: 4.2" MORTAR, MUSTARD

MUNITION: CARTRIDGE, MORTAR, 4.2", M2/M2A1 AGENT: HT EXPLOSIVE: TETRYL PROPELLANT: M6 PROCESS RATE: 50/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
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32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

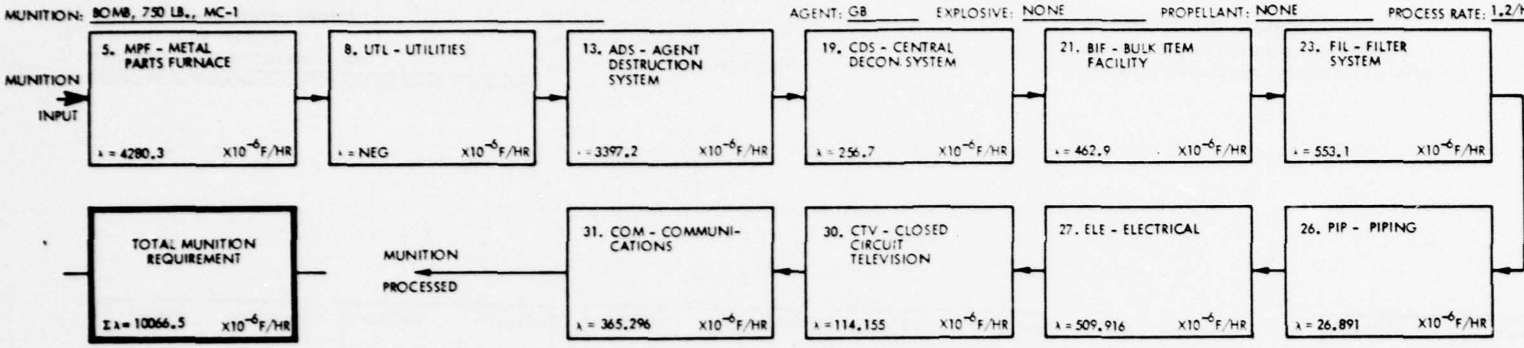
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

6. RDM - ROCKET DEMIL MACHINE
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
19. CDS - CENTRAL DECON SYSTEM
21. BIF - BULK ITEM FACILITY
25. MIN - MINE DEMIL MACHINE

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: BOMB, 750 LB., MC-1   AGENT: GB   EXPLOSIVE: NONE   PROPELLANT: NONE   PROCESS RATE: 1.2/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

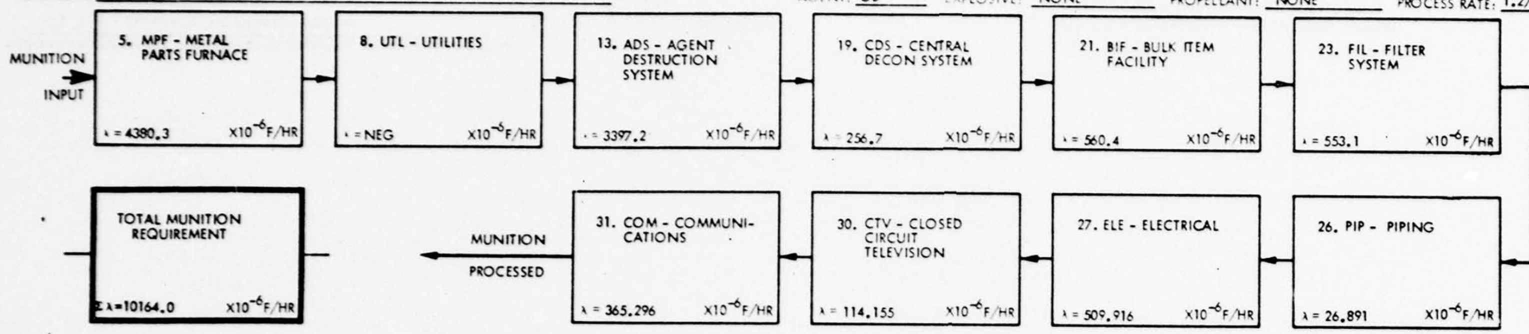
1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. [illegible] - ECC HYDRAULICS
14. [illegible] EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: BOMB, MK 94

AGENT: GB EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: 1.2/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
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33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

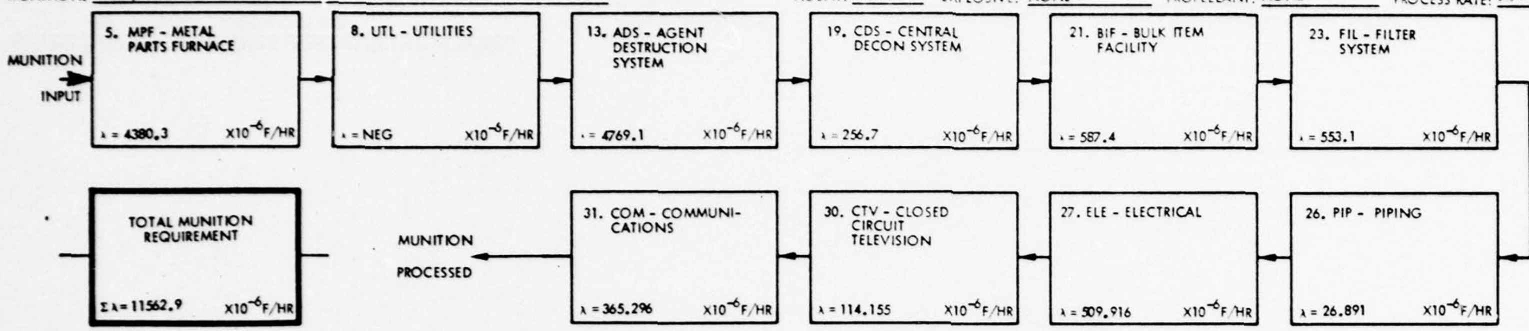
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: TANK, SPRAY, TMU-28/B   AGENT: VX   EXPLOSIVE: NONE   PROPELLANT: NONE   PROCESS RATE: .2/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

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12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
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36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

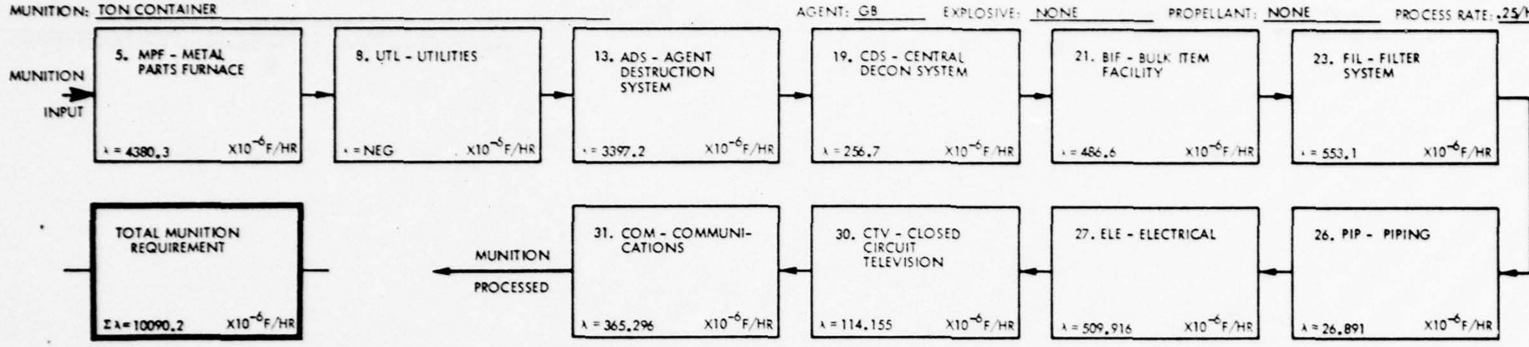
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. ECC HYDRAULICS
14. - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: TON CONTAINER   AGENT: GB   EXPLOSIVE: NONE   PROPELLANT: NONE   PROCESS RATE: .25/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

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12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

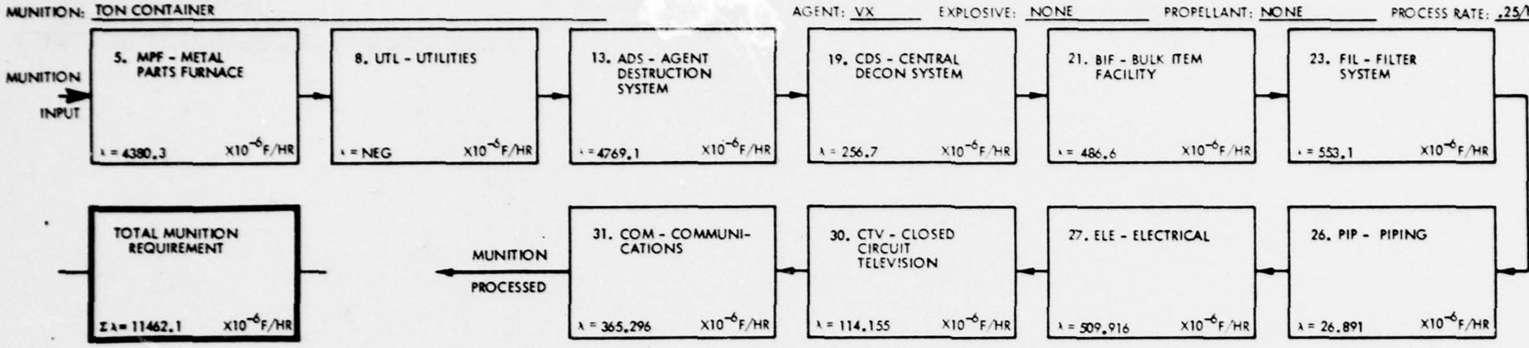
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
9. EHM - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

RELIABILITY LOGIC DIAG[illegible] CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: TON CONTAINER AGENT: VX EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: .25/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

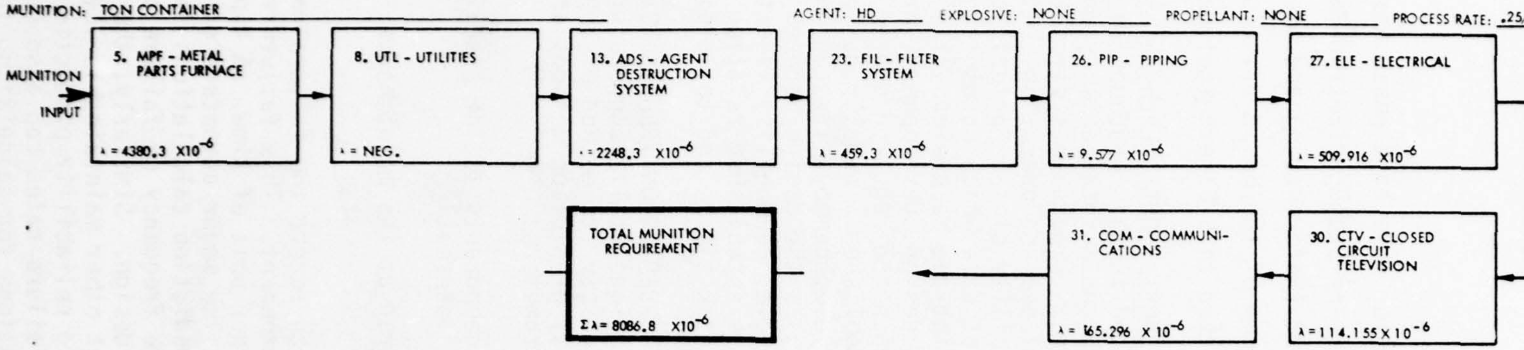
BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. [illegible] - ROCKET DEMIL MACHINE
9. [illegible] - ECC HYDRAULICS
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

RELIABILITY LOGIC DIAGRAM-CAMDS MUNITION DEMILITARIZATION

MUNITION DEMILITARIZATION PROCESS FLOW: TON CONTAINER, MUSTARD

MUNITION: TON CONTAINER AGENT: HD EXPLOSIVE: NONE PROPELLANT: NONE PROCESS RATE: .25/HR



BUILDING BLOCKS NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT:

7. DUN - DUNNAGE INCINERATOR SYSTEM
10. CON - CONTROL MODULE
12. PSC - PERSONNEL SUPPORT COMPLEX
20. PDF - PROJECTILE DISASSEMBLY FACILITY
28. MOD - SCALE MODEL
29. PER - PERIMETER MONITORING
32. CML - CHEMICAL LABORATORY
33. DET - DETECTORS
34. TDP - TECHNICAL DATA PACKAGE
36. TNG - TRAINING
37. RAM - REPAIR AND MAINTENANCE
38. SMP - SYSTEM MANAGEMENT AND PLANNING
39. OES - OPERATIONAL ENGINEERING SUPPORT
40. SIT - INITIAL TEST & SITE DEVELOPMENT
41. SYS - SYSTEM INTEGRATION

BUILDING BLOCKS NOT APPLICABLE TO THIS MUNITION:

1. UPA - UNPACK AREA
2. ECC - EXPLOSIVE CONTAINMENT CUBICLE
4. DFS - DEACTIVATION FURNACE SYSTEM
6. RDM - ROCKET DEMIL MACHINE
8. LTL - UTILITIES
14. ETS - EXPLOSIVE TREATMENT SYSTEM
15. PDM - PROJECTILE DEMIL MACHINE
18. PPD - PROJECTILE PULL AND DRAIN MACHINE
19. CDS - CENTRAL DECON SYSTEM
21. BIF - BULK ITEM FACILITY
22. MHE - MATERIAL HANDLING EQUIPMENT
24. MOR - MORTAR DEMIL MACHINE
25. MIN - MINE DEMIL MACHINE
35. SCS - SITE CONTROL SYSTEM

5.2.3 Maintainability Data

5.2.3.1 Maintenance Basis

The maintainability effort for this task phase has been based on the principles set forth in the Military Standardization Handbook for Maintainability Predictions, MIL-HDBK-472 (Reference 1) and the definitions set forth in Section 3.4 herein. Some of the basic principles set forth in MIL-HDBK-472 which greatly affected this effort include:

> BASIC ASSUMPTIONS AND INTERPRETATIONS· Each maintainability prediction procedure included in this handbook depends upon the use of recorded reliability and maintainability data and experience which have been obtained from comparable systems and components under similar conditions of use and operation. It is also customary to assume the applicability of the "principle of transferability." This assumes that data which accumulated from one system can be used to predict the maintainability of a comparable system which is undergoing design, development, or study. This procedure is justifiable when the required degree of commonality between systems can be established. Usually during the early design phase of the life cycle, commonality can only be inferred on a broad basis. However, as the design becomes refined, during later phases of the life cycle, commonality is extendable if a high positive correlation is established relating to equipment functions, to maintenance task times, and to level of maintenance.
>
> ELEMENTS OF MAINTAINABILITY PREDICTION TECHNIQUES: Each maintainability prediction technique utilizes procedures which are specifically designed to satisfy its method of application. However, all maintainability prediction methods are dependent upon at least two basic parameters:
>
> a) Failure rates of components at the specific assembly level of interest
>
> b) Repair time required at the maintenance level involved.
>
> There are many sources which record the failure rate of parts as a function of use and environment. This failure rate is expressed as the number of failures per unit of time. A typical measure is "failures per 10^6 hours." The major advantage of using the failure rate in maintainability prediction calculations is that it provides an estimate of the relative frequency of failure of those components which are utilized in the design. Similarly, the relative frequency of failure of components at other maintainable levels can be determined by employing standard reliability prediction techniques using parts of failure rates. Failure rates can also be utilized in applicable regression equations for calculating the maintenance

action time. Another use of the failure rate is to weight the repair times for various categories of repair activity, in order to provide an estimate of its contribution, to the total maintenance time.

Repair times are determined from prior experience, simulation of repair tasks, or past data secured from similar applications. Most procedures break up the "maintenance action", which is a more general expression than "repair action", into a number of basic maintenance tasks whose time of performance is summed to obtain the total time for maintenance action.

A conscious effort has been made throughout this task to assure that these principles were applied in the most appropriate manner to obtain the most valid results possible.

MIL-HBDK-472 contains four (4) maintainability prediction procedures. Procedures I and III are applicable solely to electronic systems and equipment which preclude their application to the CAMDS system. Procedures II and IV can, however, be applied to all systems and equipments. Procedure II requires more data, and data at a more detailed level than Procedure IV. The information required for each procedure is as follows:

Information Required to Complete Maintainability Procedures

Procedure II

For corrective maintenance

a) Packaging to the extent that detailed hardware configurations can be established
b) Diagnostic procedure
c) Repair methods
d) Parts listing
e) Operating stresses
f) Mounting methods
g) Functional levels at which alignment and checkout occur.

For active maintenance

The respective maintenance task times for corrective and preventive maintenance must have been determined.

Procedure IV

Complete system documentation portraying:

a) Functional diagrams
b) Physical layouts
c) Front panel layouts
d) End item listings with failure rates.

Since Procedure II required data not available within the time frame of this contract, Procedure IV was followed as the guideline for this task.

5.2.3.2 Basic Maintainability Equations

For a building block module, availability was treated as a function of maintenance and reliability via the following equation (Reference 2, pages 2 through 7, paragraph 2-46):

$$\text{Availability} = \frac{\text{Uptime}}{\text{Uptime + Downtime}}$$

$$= \frac{\text{MTBM}}{\text{MTBM + MMT}}$$

where MTBM is Mean-Time-Between-Maintenance and MMT is Mean-Maintenance time. For the special case when no preventive maintenance is required, administrative and supply time are negligible, and no redundancy exists; the equation for availability is a direct relationship between the reliability factor, mean-time-between-failures (MTBF), and the maintainability factor, mean-time-to-repair (MTTR) (Reference 3):

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF + MTTR}} = \frac{1}{1 + \frac{\text{MTTR}}{\text{MTBF}}}$$

All terms in these equations are as defined in Section 3.4.

The realities of the CAMDS design and anticipated operational procedures indicate that the special case formula is applicable to CAMDS system. While preventive maintenance is required and is expected to be extensive, it is an operational ground rule that the demilitarization process will not be shut down so that it can be carried out. Rather, preventive maintenance will be accomplished while the process is down for corrective maintenance.

A corollary assumption is that the process will not be continued in a shutdown mode after the corrective maintenance has been completed for the purpose of accomplishing further preventive maintenance. An initial ground rule and agreement of this study was that replacement parts/repairs materials would be available on site and would be readily available (administrative and supply time are negligible). A very limited amount of redundancy exists in the CAMDS system compared with the total hardware requirement. Therefore, the inaccuracies introduced by neglecting this redundancy are negligible. The special case formula for availability was used consistently in this analysis.

5.2.3.3 Maintainability Data Base

The maintainability data base used in this task phase was recognized as a critical element to the validity of the results obtained in this task and all subsequent phases of the total task. The most appropriate maintenance data sources to realistically model the actual CAMDS system were considered to be, in order of preference:

- Data obtained from CAMDS testing
- Data obtained from RMA operations
- Data recorded under a controlled program subjected to CAMDS applicability criteria
- Generic data judged to be applicable
- Engineering judgements.

While data obtained from CAMDS testing would most realistically model the CAMDS system (other than data obtained from actual CAMDS operations), they are currently limited in quantity and will be available only "after the fact" for this effort. Data were available from RMA operations, but they were also limited in quantity because the computerized documentation system contains only data generated since February 1975 at the present time. An additional constraint was that the data were most readily available at the "subsystem major component" level (i.e., Versatran - 8203 Head, 8209 Flapper, 8213 Programmer, 8214 general etc.) and not to the component level which would have been most desirable for this analysis. Component level data were stated to be available on an individual item request basis. No such data were made available for this analysis. Since the two most appropriate maintenance data sources proved to be unavailable or excessively restrictive, TRW concentrated efforts on obtaining data from the third most appropriate source (data recorded under a controlled program and subjected to CAMDS applicability criteria) and used data from the two prime sources as supplement as they became available. Generic data and engineering judgments were used only when the three best sources were not sufficient.

The search for a suitable maintenance data source indicated that there are many technical reports written on the theoretical aspects of maintainability, but there is much less effort spent in gathering and maintaining data banks of actual maintenance experience. The most extensive and applicable data source found was published by Rome Air Development Center (RADC) in References (4) and (5). These data were gathered and processed by the Chrysler Corporation Missile Division under contract to the government. The data were from the JUPITER Weapon System. The data have several advantages:

- They were gathered and processed under a controlled system by controlled procedures.
- They are large in quantity.
- They contain many components generically similar to CAMDS components.
- Maintenance data for both mechanical and electrical components were obtained from a single source.
- They break out "remove and replace" times as a separate entry.
- They were taken from a military system.

The data have several disadvantages:

- "Remove and replace" times include diagnosis, remove and replace, and checkout time as one entry.
- Data source was a system not as similar to the CAMDS system as was desirable. One of the most apparent dissimiliarities was the conditions under which maintenance actions will be carried out. Much of the CAMDS maintenance work will require that protective clothing be worn. There is no similar known requirement for the data base system.

5.2.3.4 Maintainability Data Factors

Recognizing the limitations of the maintenance data source, it was determined to be realistic and desirable to attempt to factor the base data to account for these limitations. The obvious limitation of the data base relative to the CAMDS application is that CAMDS personnel will often be required to perform maintenance in protective clothing. Further, this protective clothing will likely impede the rate of maintenance operations.

Equating the basic maintenance data to a "street clothes" situation the following "Condition B - Suit Requirement" factor were assigned, based on a survey of studies undertaken to determine the effects of protective clothing on the ability of an individual to perform certain manual tasks:

Maintainability Factor (Suit Requirement)

Suit Requirement	Condition B Factor
Street	1
Gloves	1.5
Mask and Gloves	2
Pressurized Suit	3

It is recognized that the test results from space flights suits (the subject of the studies included in the survey) are not directly transferable to the CAMDS protective clothing/rubber suits. It is, however, (in lieu of similar tests on the CAMDS suits) a logical conclusion, based on the data, that the use of protective clothing by maintenance personnel will have an impeding effect on the rate of maintenance operations. When the time to don the suit and the loss of ability to perform tasks in the suit (grip strength decrement ≈47%, dexterity decrement ≈65%, dexterity decrement ≈71 to 90% (depending on glove fit), and tactility task scores at times increased by a factor of 10) are taken into consideration, it is believed that the maintenance time factors shown are reasonable and not excessive. Discussions with CAMDS personnel familiar with the suit maintenance experience at RMA further substantiate factors of this order of magnitude. These factors were used consistently in this analysis. Summary results of studies covered in the survey that resulted in the assignment of these factors are included herein:

Reference 6 states in the discussion of its purpose that the study, "----was undertaken to determine the content of a test battery which will allow assessment of motor performance in full pressure suits under various conditions of suit pressurization, using a minimum of time and test equipment." Areas covered within this framework included: mobility, workspace requirements, forced exerted, static and dynamic antropometry, psychomotor coordination, dexterity, and visual field limitations. Quantitative data of interest to CAMDS that were discussed in this study included:

> Huchingson (Reference 7) compared, among other factors, the grip strength allowed by the Mark IV and the Gemini suits, pressurized and unpressurized. He found about a 35 percent decrement attributable to the suit itself. A further 12 percent decrement resulted from suit pressurization.
>
> Generally, it has been found that the unpressurized pressure suit interfers with dexterity as measured. Moreover, measured dexterity varies inversely with suit pressurization. For example, Walk (Reference 8) found that Purdue Pegboard (this test involves using the fingers to grasp, transport, and insert small pegs in holes, and to place collars around the pegs) performance for the unpressurized A/P22S-2 suit was about 65 percent or less than that in the ungloved state. Pressurization of the suit to 2.5 psi caused a further decrement to about 35 percent or less of the measured dexterity of the ungloved hand.

Reference 9 states in its Abstract that the report, "----describes the pressure garment assemblies, gives some of the logic involved in desi selection, reviews the evaluation procedures and presents the results obtained in the battery of tests." The results of some of these tests are of interest to CAMDS. The results of these tests are shown here in their entirety.

Based on observations at the CAMDS site an additional maintainability factor "Condition C-Accessibility/Space Limitation" was assigned. For instance, the demil machines when installed in the ECC will not leave an ideal amount of space for maintenance personnel/operations. The factor assigned to account for such situations is as follows:

Maintainability Factor (Accessibility/Space Limitations)

Accessibility/Space Limitation	Condition C Factor
No Limitation	1
Limitation	1.33

This factor was used in this analysis on a judgment basis by the individual preparing the Building Block work sheets.

HAND DEXTERITY

Hand and finger dexterity tests conducted with subjects wearing the MD-1 and MD-2 pressure assemblies in April 1966 were repeated in August 1966 with the same subjects wearing the MD-3 and MD-4.

The manipulative dexterity of each subject's hands was measured for each of the following conditions:

1. Subject suited, without helmet or gloves, ventilation only.
2. Subject suited completely, with slight vent pressure.
3. Suit pressurized to 3.7 psig.

Condition 1 constitutes a baseline performance for the subject against which his decrement in performance under conditions 2 and 3 are compared. The procedures followed in using the Purdue Pegboard are outlined in AMRL TDR 54-41, D.Walk, "Finger Dexterity of the Pressure-Suited Subject." Results of the following tests are given in Table 5-1.

Table 5-1. Dexterity-Percent Retention

Test	Condition	Right Hand	Left Hand	Both Hands	Assemb
1	1-Vent	70.9	72.5	53.2	75.7
1	2-3.7 psig	36.4	47.1	29.8	29.3
2	1-Vent	60.4	61.4	47.4	51.7
2	2-3.7 psig	41.7	20.5	15.8	13.8
3	1-Vent	51.9	62.3	49.0	44.2
3	2-3.7 psig	35.2	37.7	30.6	23.2
4	1-Vent	40.4	24.5	24.4	15.6
4	2-3.7 psig	13.5	11.3	8.9	9.9

TEST 1

Suit: MD-1 with thermal coverall.

Subject: A

Glove Size: F

Observation on Glove Fit: The thumb, index and middle fingers fitted well but glove fingers 4 and 5 were long.

TEST 2

Suit: MD-2 with thermal coverall.

Subject: B

Glove Size: G

Observation on Glove Fit: The thumb fit snugly; the four glove fingers were slightly long.

TEST 3

Suit: MD-3 with thermal coverall.

Subject: A

Glove Size: F (without metal fingernails)

Observation on Glove Fit: All fingers reached the ends of the glove fingers when unpressurized. Little ballooning noted under pressure.

TEST 4

Suit: MD-4 with thermal coverall.

Subject: B

Glove Size: Indicated G; size worn, H with metal fingernails.

Observation on Glove Fit: The unpressurized glove fingers were about 1/2-inch too long and the metal fingernails hampered performance. The subject was uncomfortable due to a very restrictive suit fit.

TACTILITY OF THE HANDS

This procedure intends to evaluate the subject's ability to recognize physical differences by feel while blindfolded*. The subject accomplished each task several times under each condition: (1) without gloves; (2) with gloves, suit ventilated; and (3) with suit pressurized to 3.7 psig.

The tasks consist of:

a. Recognition of short rod sections less than 1-inch in outside diameter.
b. Recognition of multisided rods or prisms having varied numbers of flats on similar sized bars.
c. Recognition of different mass in objects of the same size and shape.
d. Detection of location of smallest hole in a flat bar of metal.
e. Insertion of large cap screws into threaded holes, one to each exposed side of a metal cube placed before the subject.
f. Ability to reach the multiple controls on an aircraft control stick while holding it in one gloved hand.

Scores shown in Table 5-2 do not appear to be conclusive although they indicate some of the tasks are too easy. More refinement in procedures and tasks should produce more meaningful results.

Generally, subjects identified most of the diameters, prisms, and weights correctly. The assembly of bolts, and control stick usually could not be completed pressurized. The G-4C gloves hurt the subject's knuckles, indicating an improper fit. Bringing both hands together for a task was tiring in all assemblies. Most serious was the muscle fatigue in the forearms and hands that caused cramps and enforced periods of rest after short periods of effort while pressurized to 3.7 psig.

---

*Possible correlation to performing maintenance actions on a demil machine in the ECC where conditions may not allow visual contact with every bolt, nut, screw etc.

Table 5-2 Tactility Scores

		G-4C Medium	G-4C Large	MD-1 Medium	-2 Large
Diameters	B	100	100	100	100
(percent	V	100	100	100	100
correct)	P	90	90	100	90
Prisms	B	100	100	100	100
(percent	V	100	80	100	90
correct)	P	90	30	100	90
Weight	B	100	100	100	100
(percent	V	100	80	90	80
correct)	P	80	80	100	70
Hole Detection	B	1/16	1/16	1/16	1/16
(Minimum size)	V	1/8	1/8	1/8	1/8
	P	1/8	1/8	1/8	1/8
Bolts in Block	B	35	35	35	35
(Seconds to	V	78	70	60	70
complete)	P	4/5@335	Unable	4/5@240	Unabl

B-Bare handed V-Gloves on,vented P-Gloves on,pressure 3.7 psig

DONNING-DOFFING**

Near the end of the test series the subjects attempted donning without assistance. Subject A donned the MD-1 suit but was unable to connect the helmet. Subject B got into the MD-2 but could not close the dorsal pressure sealing slide fastener. Both subjects were able to doff the suits without aid in 7 to 9 minutes. Donning the assemblies with assistance required 5 minutes, doffing about 4 minutes. Subject A donned the MD-3 up to the point of closing the pressure-sealing torso fastener where assistance was required. Closing this fastener, though difficult, can be learned by most crewmen if the suit is not too tightly fitted. Some other attempts at self-donning with this style closure have been successful. The subject accomplished the helmet connection without difficulty. Unaided doffing was accomplished in 2 minutes 46 seconds. With assistance, donning required 4 minutes 5 seconds; doffing 2 minutes 30 seconds.

When very intimately tailored for mimimum expansion pressurized, the MD-3 and -4 are difficult to don primarily in three ways:

To duck the head under the back portion and come up through the neck ring while the arms are in the suit sleeves; to pass the lower edge of the closure over the buttock; and finally to close the pressure-retaini slide fastener.

** The results of this test are considered to be indicative of a specific

5.2.4 Analyses Results - Building Blocks

The major results of analyses accomplished in the three major areas of effort - Reliability, Maintainability and Availability - are included in this section. Graphically, a series of Reliability Estimation charts are provided which are centered about the MTBF for each type of munition in process. The curves, included under Section 5.2.4.1, are plotted to allow readout of estimated reliability level by "running" mission (processing) times. A summary of these is also included in Section 5.2.4.1.

The results of both maintainability analyses and resulting effected Availability levels, are summarized graphically in Subsections 5.2.4.2 and 5.2.4.3, respectively. Table 5-3 summarizes maintainability results in terms of MTBF and MTTR by munition type. Table 5-4 summarizes availability results in terms of availability levels by munition type and includes the final effects of the reliability/maintainability analyses on processing rates. The included series of pages entitled, "Munition Availability Parameter Summary" provide the supporting analyses results, by Building Block, for these two areas of reliability/maintainability and are found at the end of Section 5.2.4.

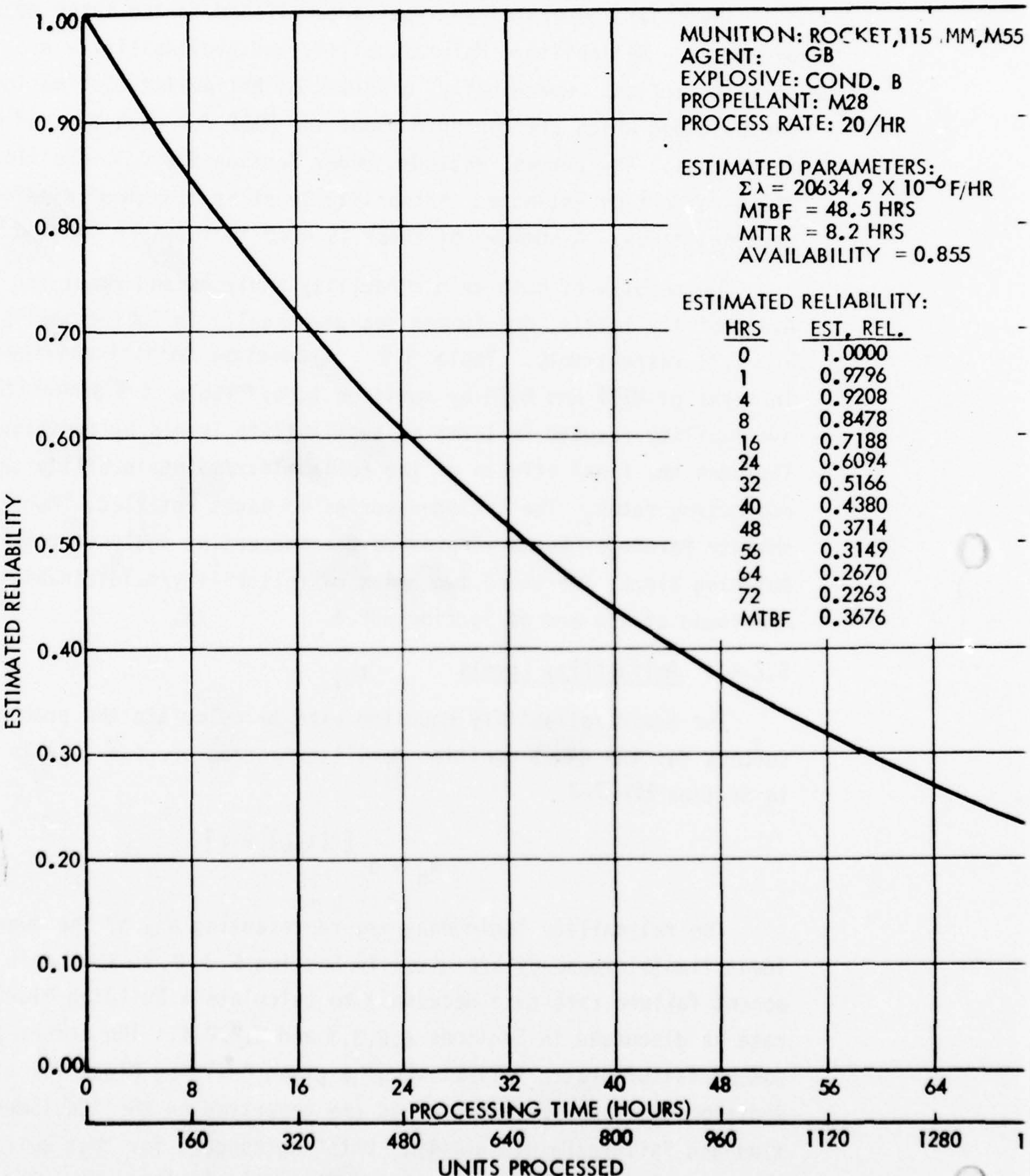
5.2.4.1 Reliability Levels

The basic reliability equation used to calculate the probability of success for the CAMDS munition demilitarization process (R_p) is as developed in Section 5.2.2.2:

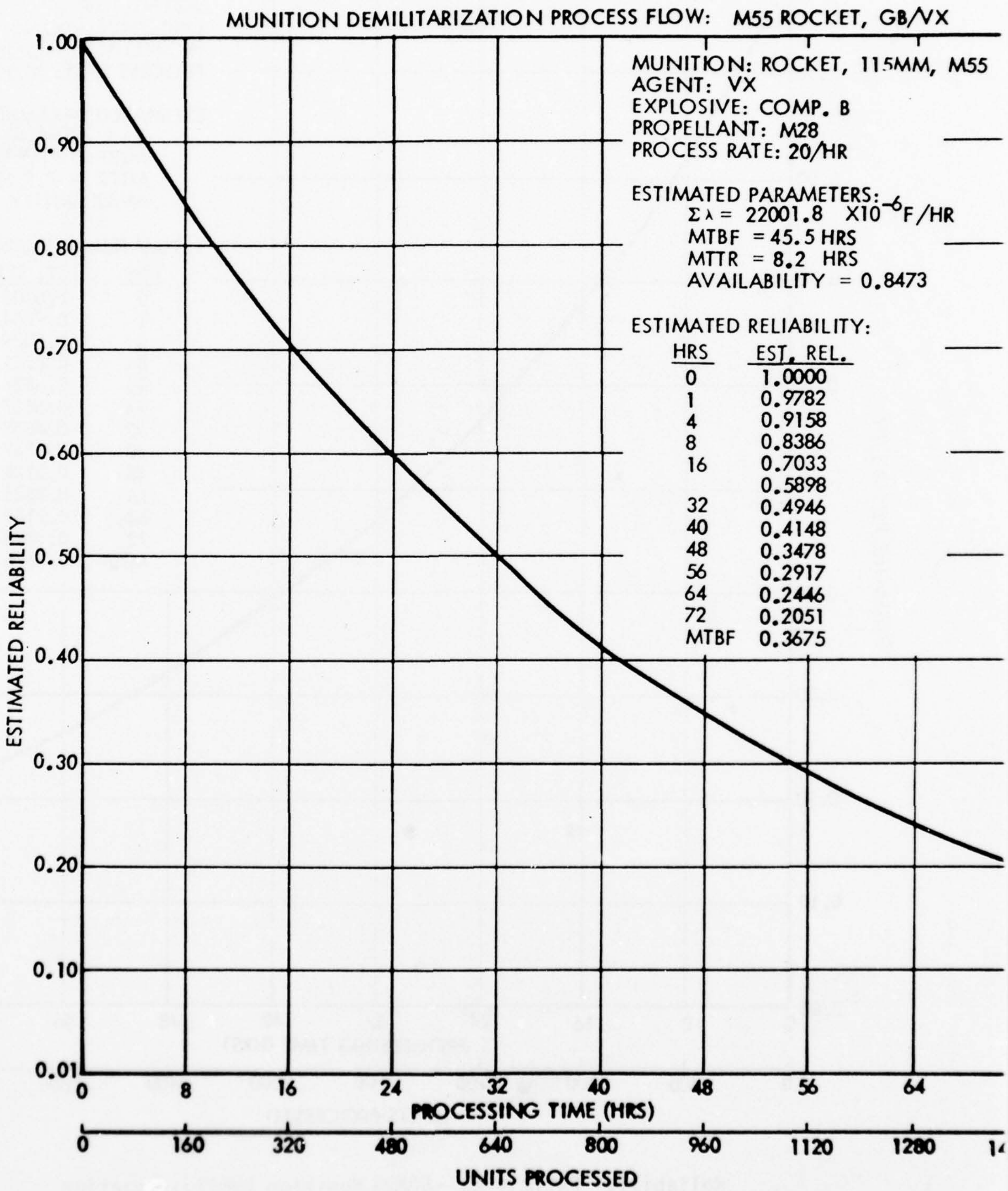
$$R_p = e^{-[\Sigma(\lambda_{BB}) \times t]}$$

The reliability logic diagrams representing any of the twenty-two (22) identifiable processes are given in Section 5.2.2.5. The basis of the component failure rate data necessary to calculate a Building Block failure rate is discussed in Sections 5.2.3.3 and 5.2.2.4. The actual total component failure rates reflective of a given Building Block for a given munition demilitarization process are generated on the "Equipment Information and Failure/Maintainability Data" worksheets for that Building Block and are summarized on the "Building Block Availability Summary" sheets in Volume II. The total failure rate for all necessary Building Blocks of a given munition demilitarization process are shown on the appropriate "Munition Availability Parameter Summary" sheets in Section 5.2.4.2

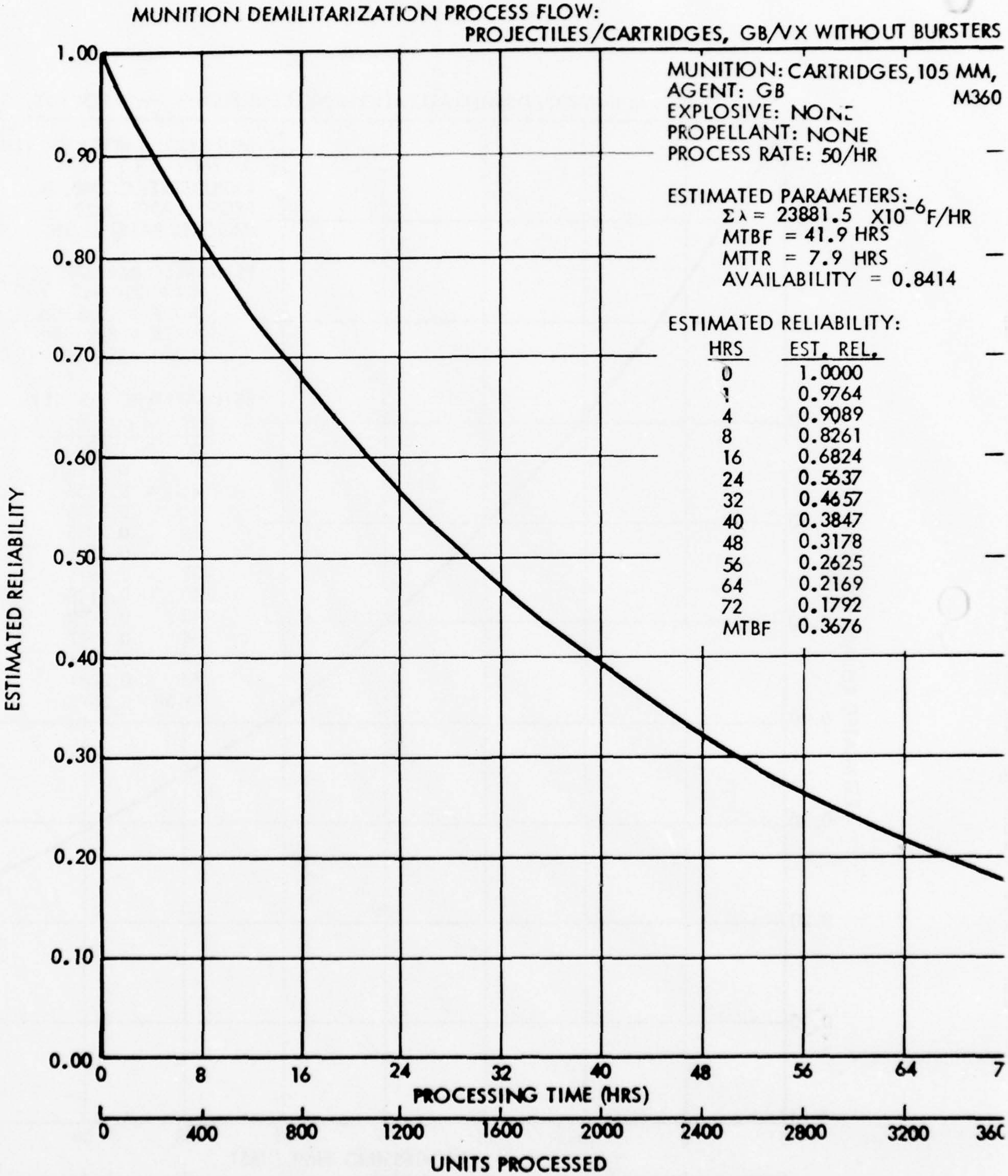
MUNITION DEMILITARIZATION PROCESS FLOW : M55 ROCKET, GB/VX



Reliability Estimation - CAMDS Munition Demilitarization

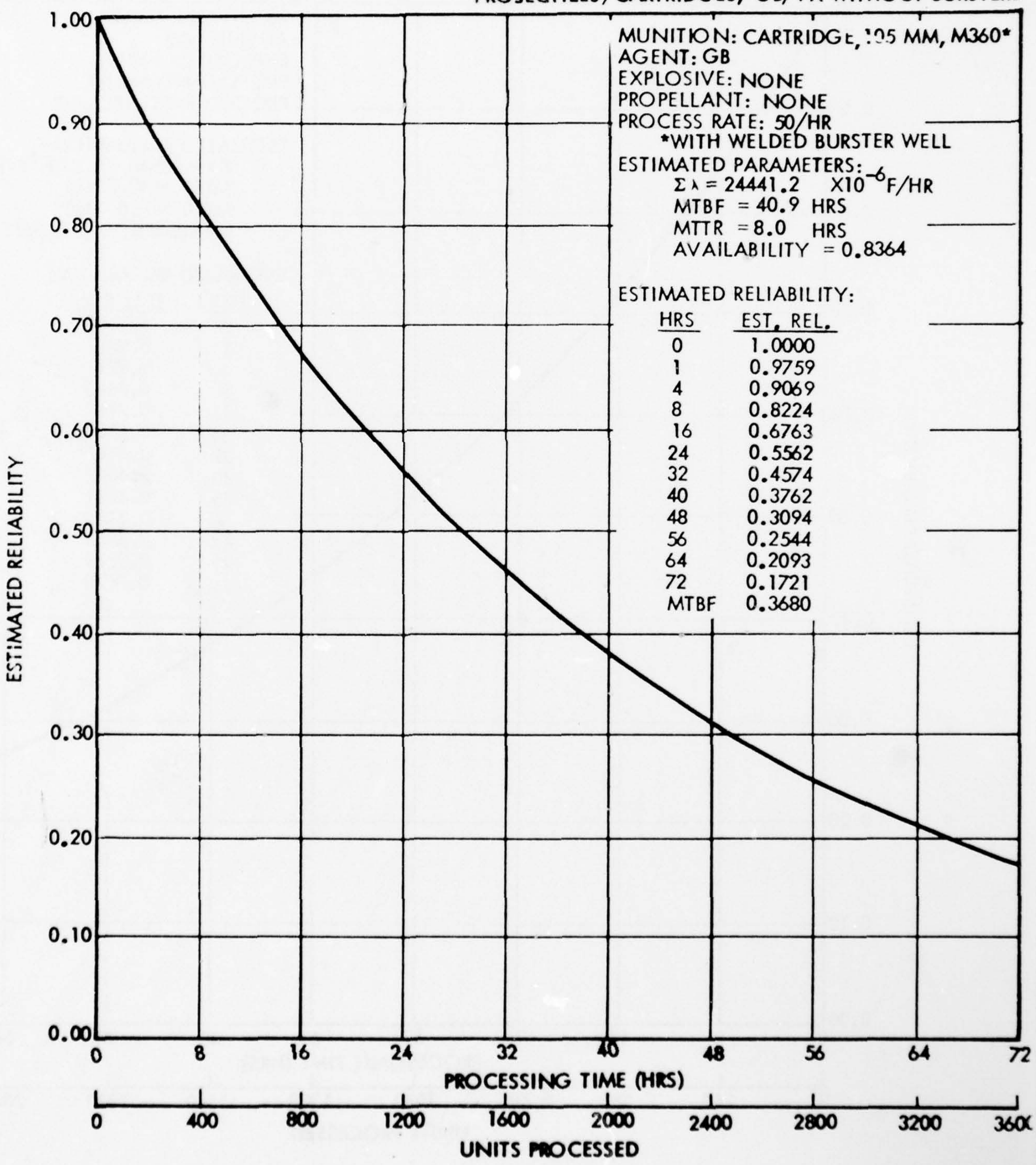


Reliability Estimation - CAMDS Munition Demilitarization



Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:
PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS



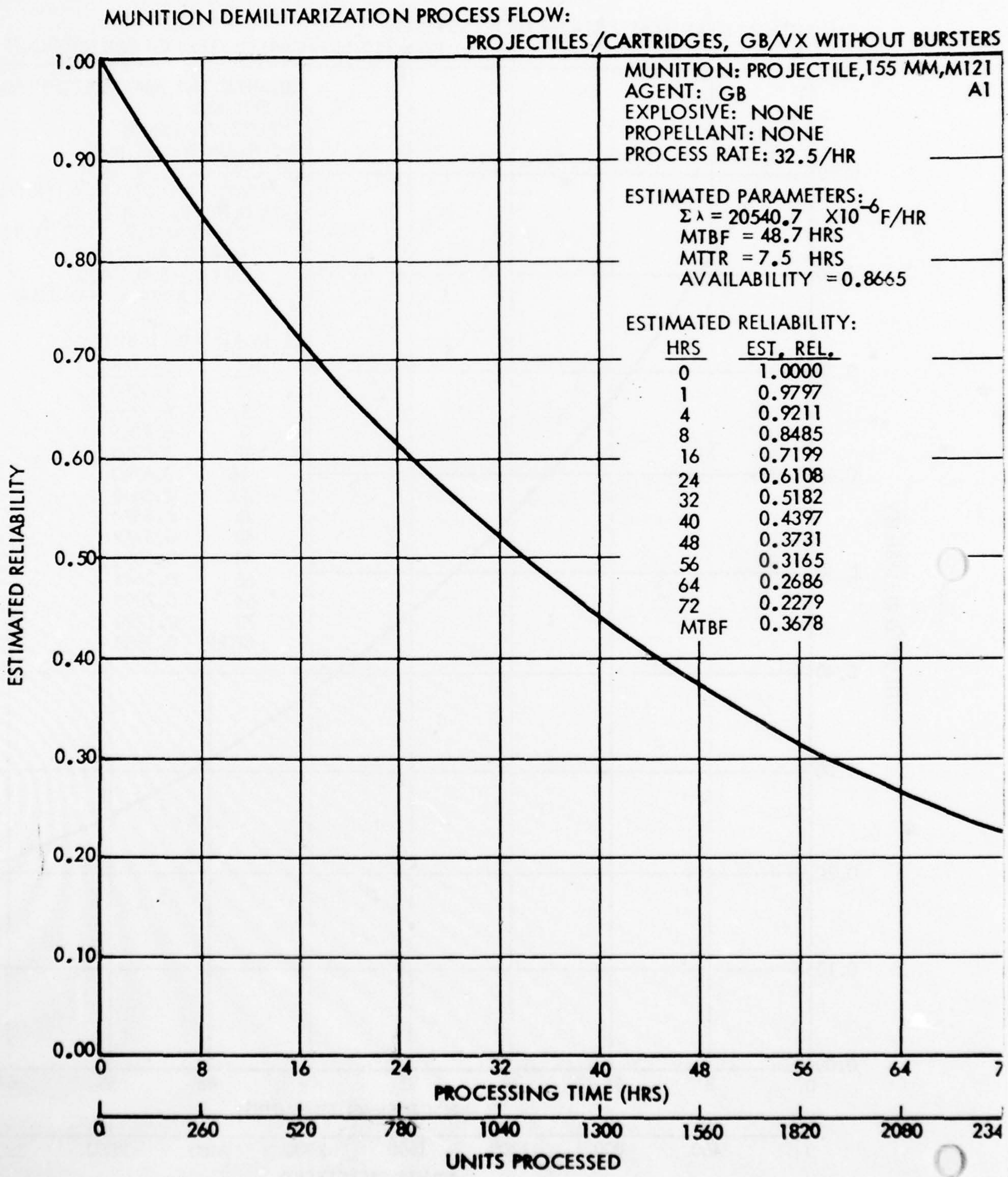
MUNITION: CARTRIDGE, 105 MM, M360*
AGENT: GB
EXPLOSIVE: NONE
PROPELLANT: NONE
PROCESS RATE: 50/HR
*WITH WELDED BURSTER WELL

ESTIMATED PARAMETERS:
$\Sigma\lambda = 24441.2 \times 10^{-6}$ F/HR
MTBF = 40.9 HRS
MTTR = 8.0 HRS
AVAILABILITY = 0.8364

ESTIMATED RELIABILITY:

HRS	EST. REL.
0	1.0000
1	0.9759
4	0.9069
8	0.8224
16	0.6763
24	0.5562
32	0.4574
40	0.3762
48	0.3094
56	0.2544
64	0.2093
72	0.1721
MTBF	0.3680

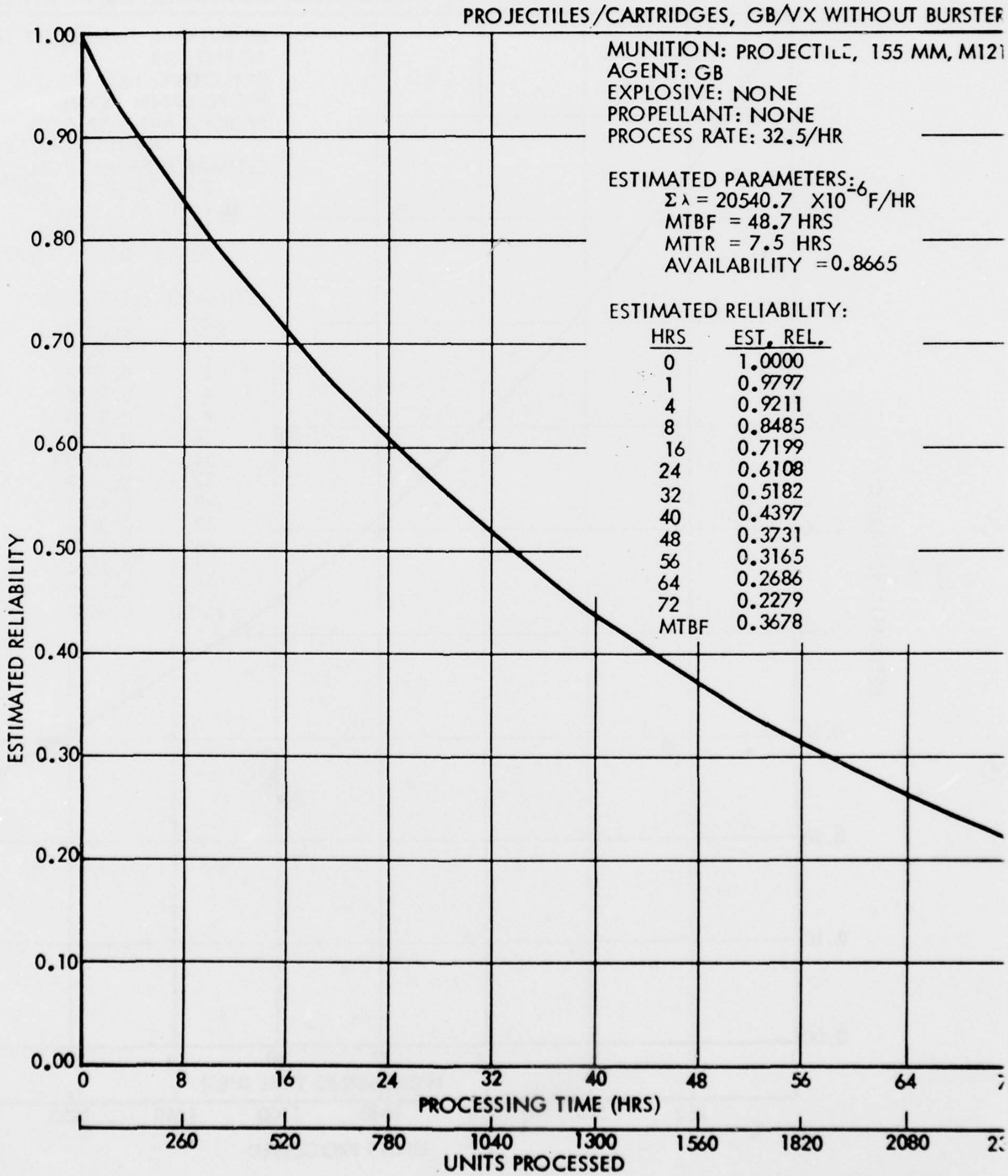
Reliability Estimation - CAMDS Munition Demilitarization



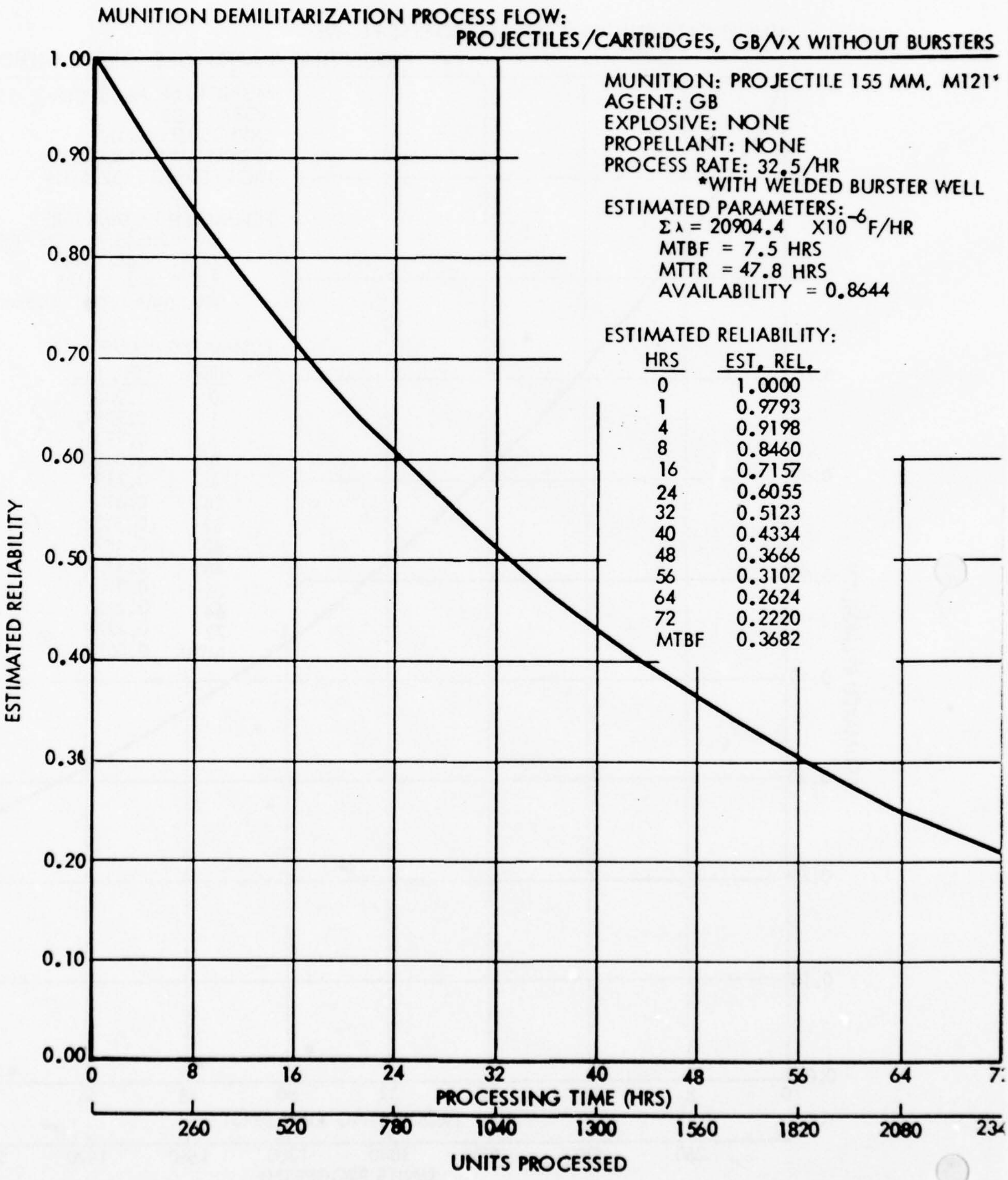
Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:

PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTER

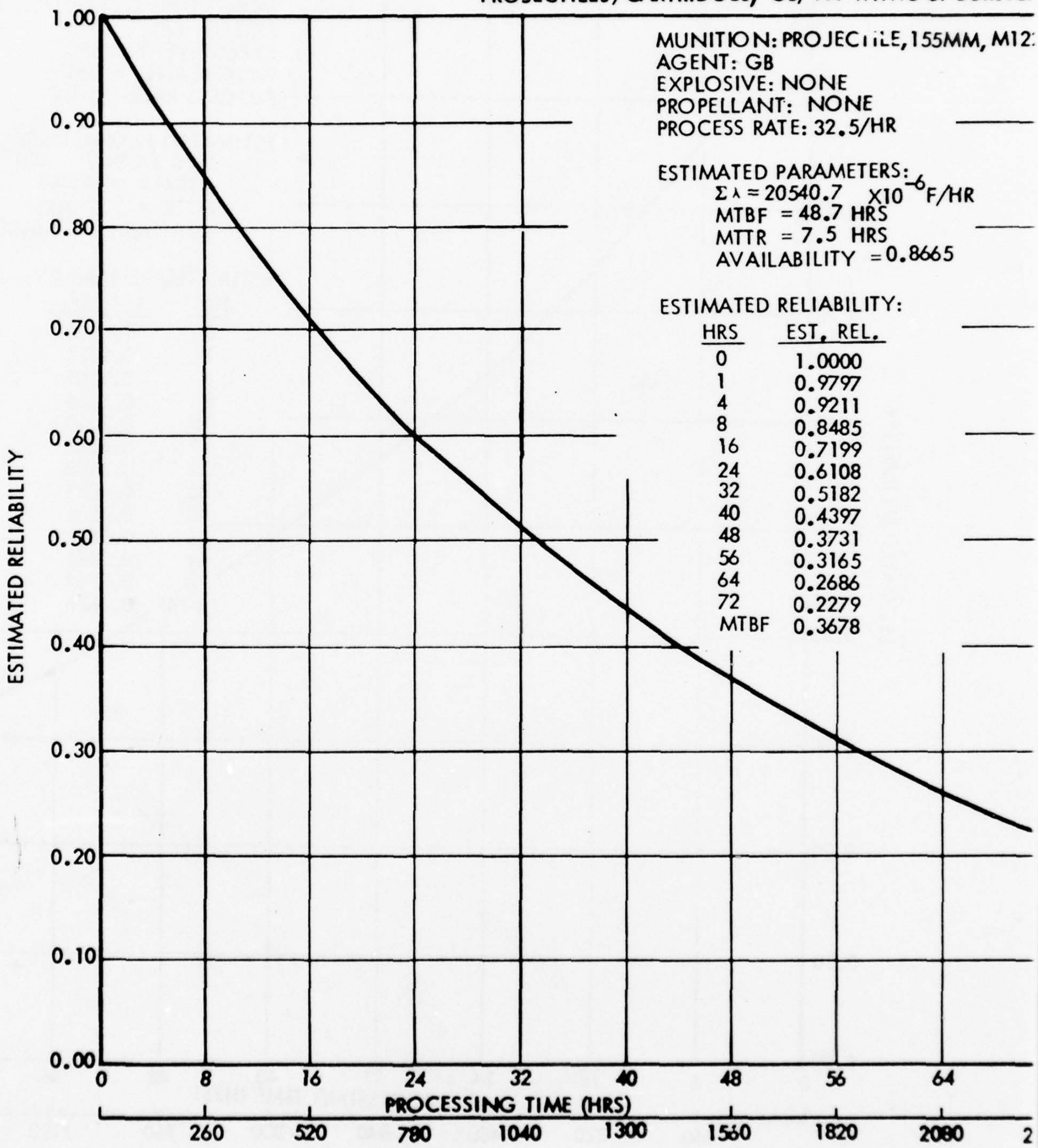


Reliability Estimation -CAMDS Munition Demilitarization



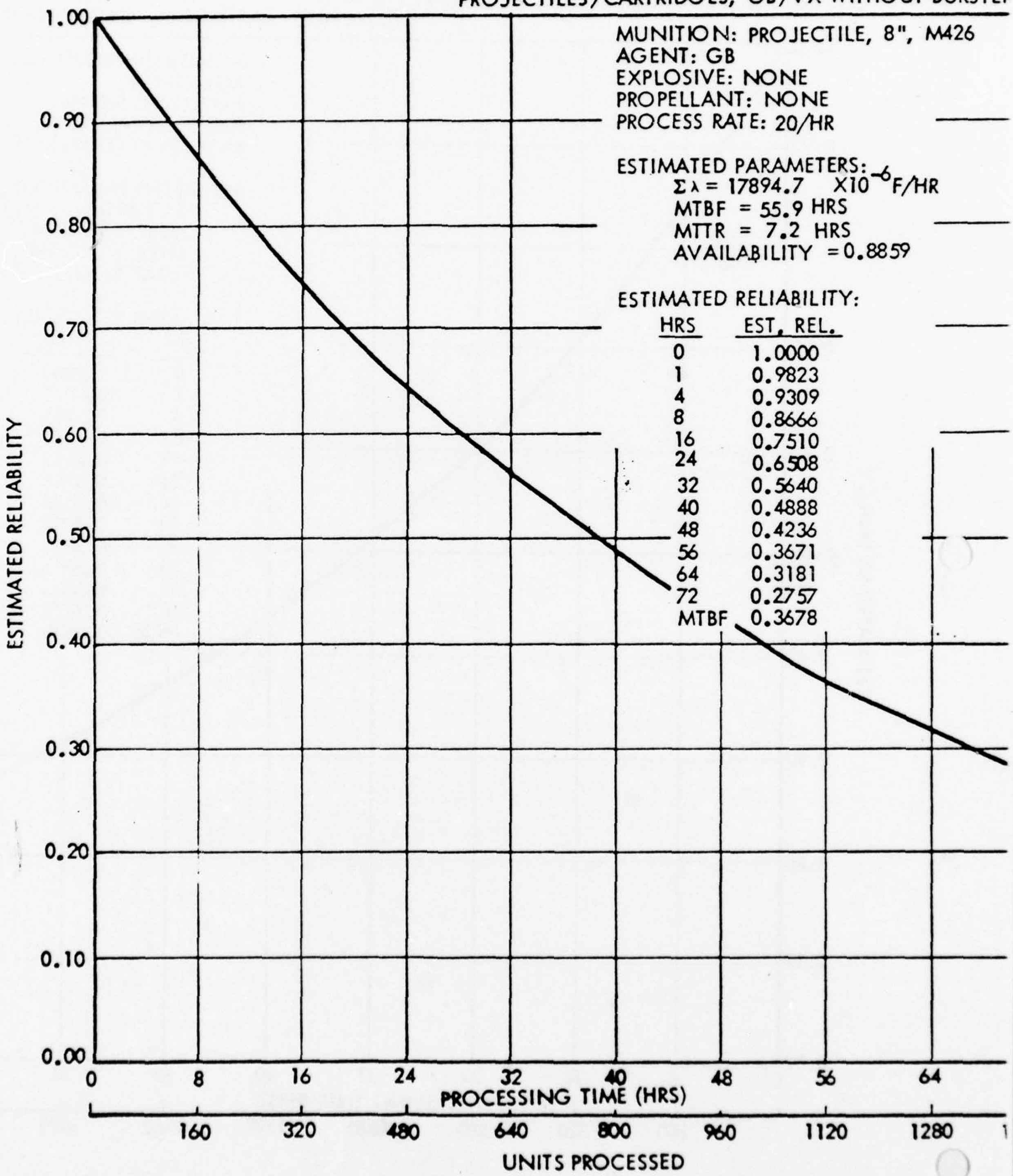
Reliability Estimation -CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:
PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTEF



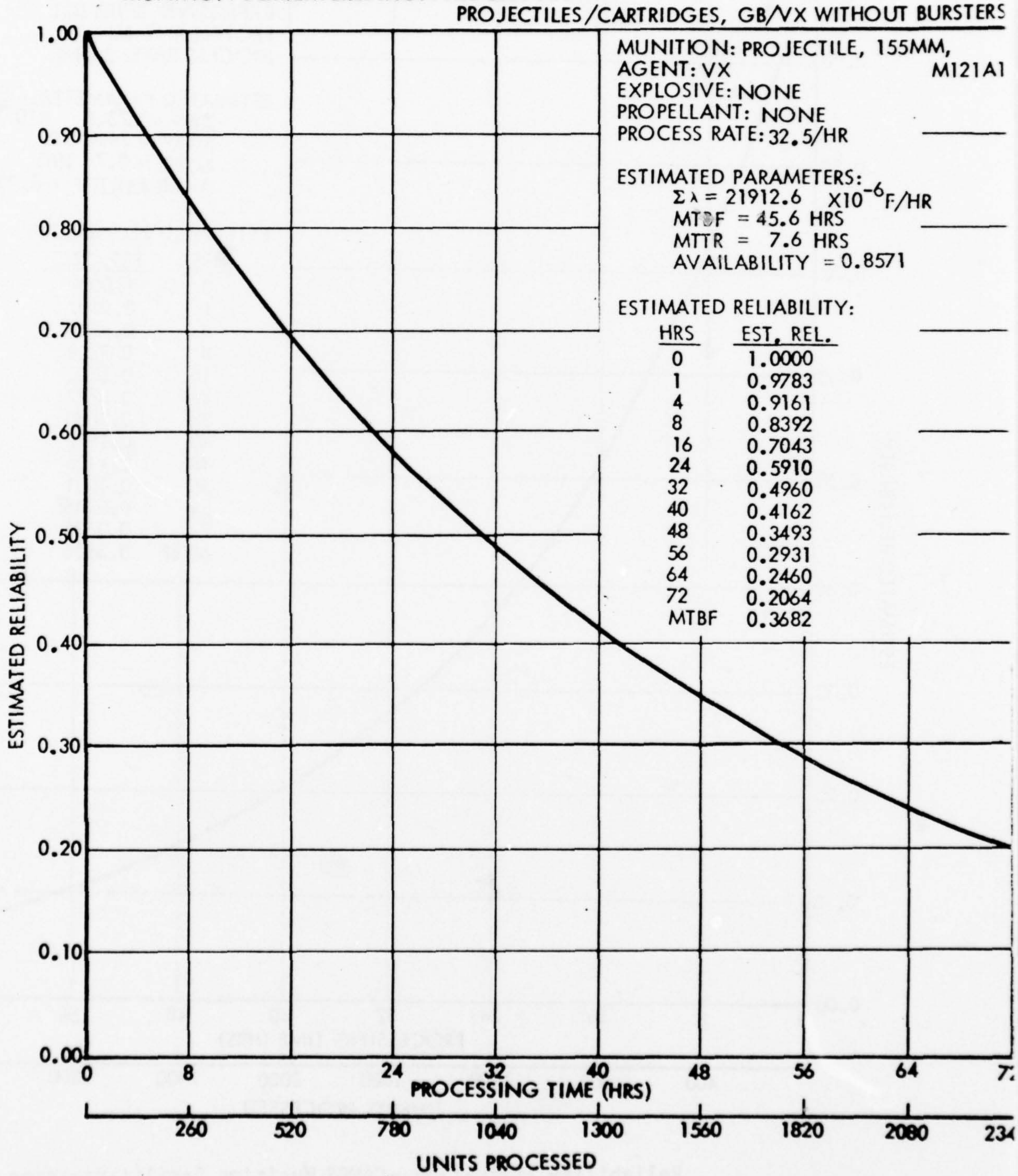
Reliability·Estimation – CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:
PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTER



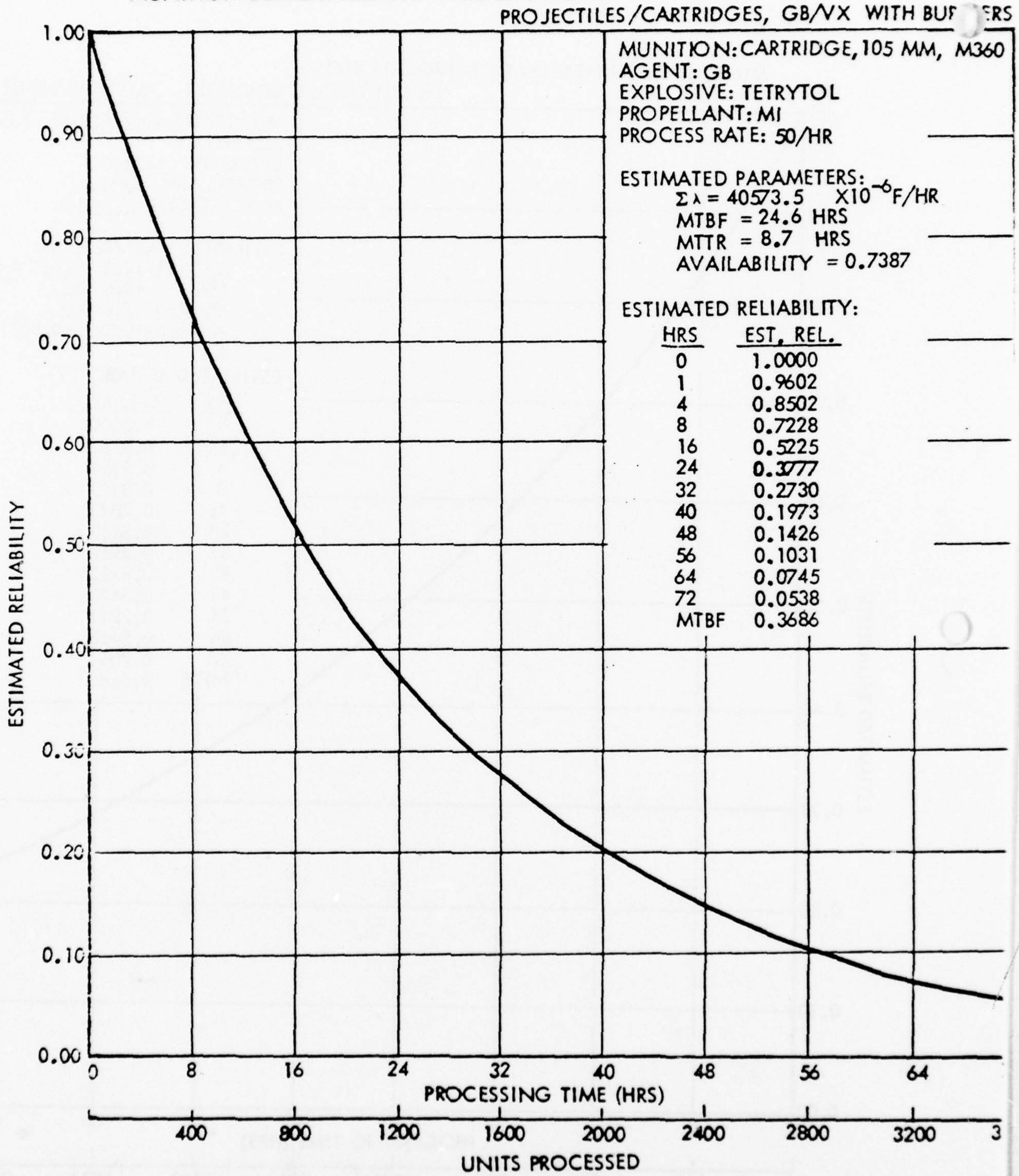
Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:
PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

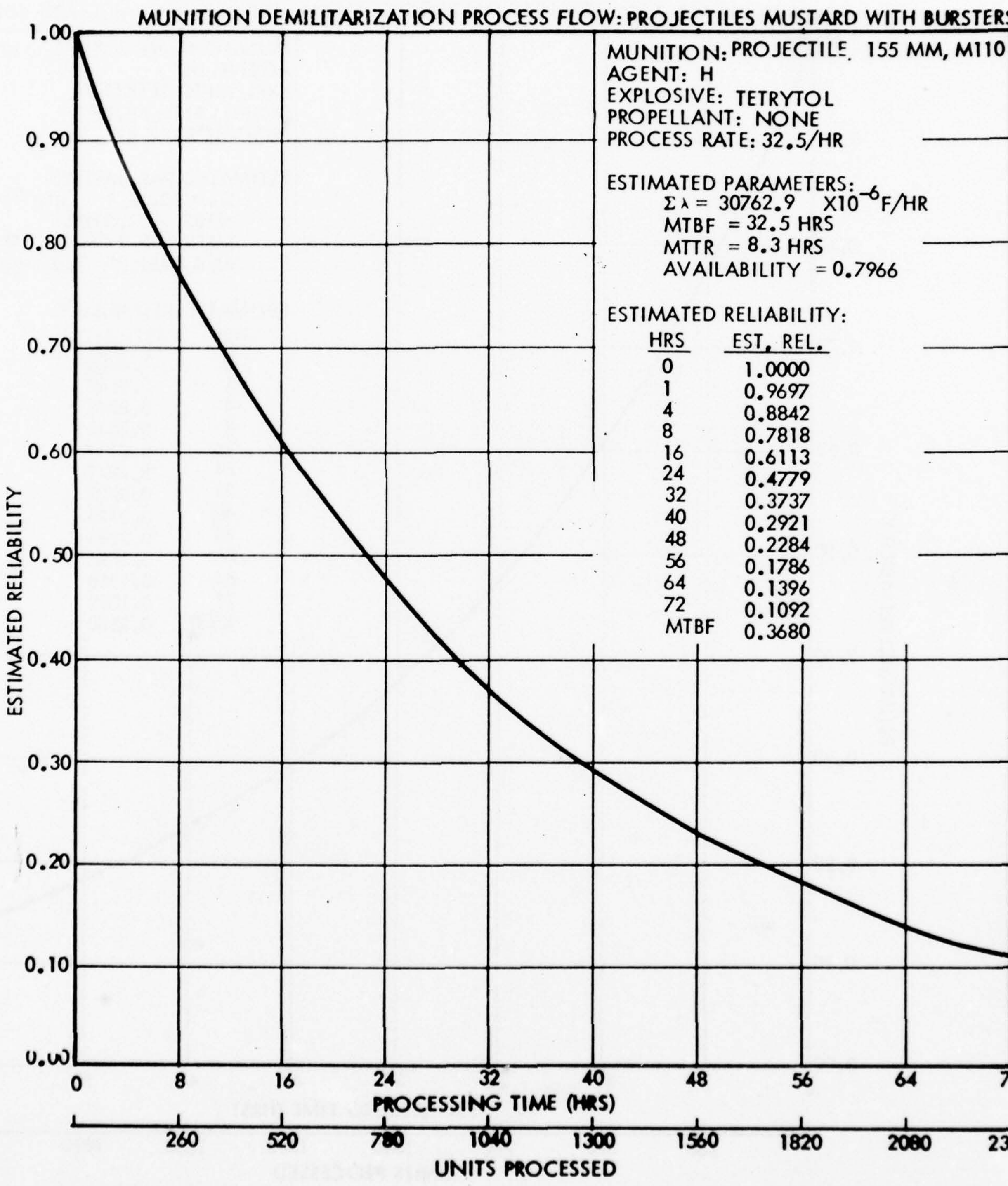


Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW:
PROJECTILES/CARTRIDGES, GB/VX WITH BUR[illegible]ERS

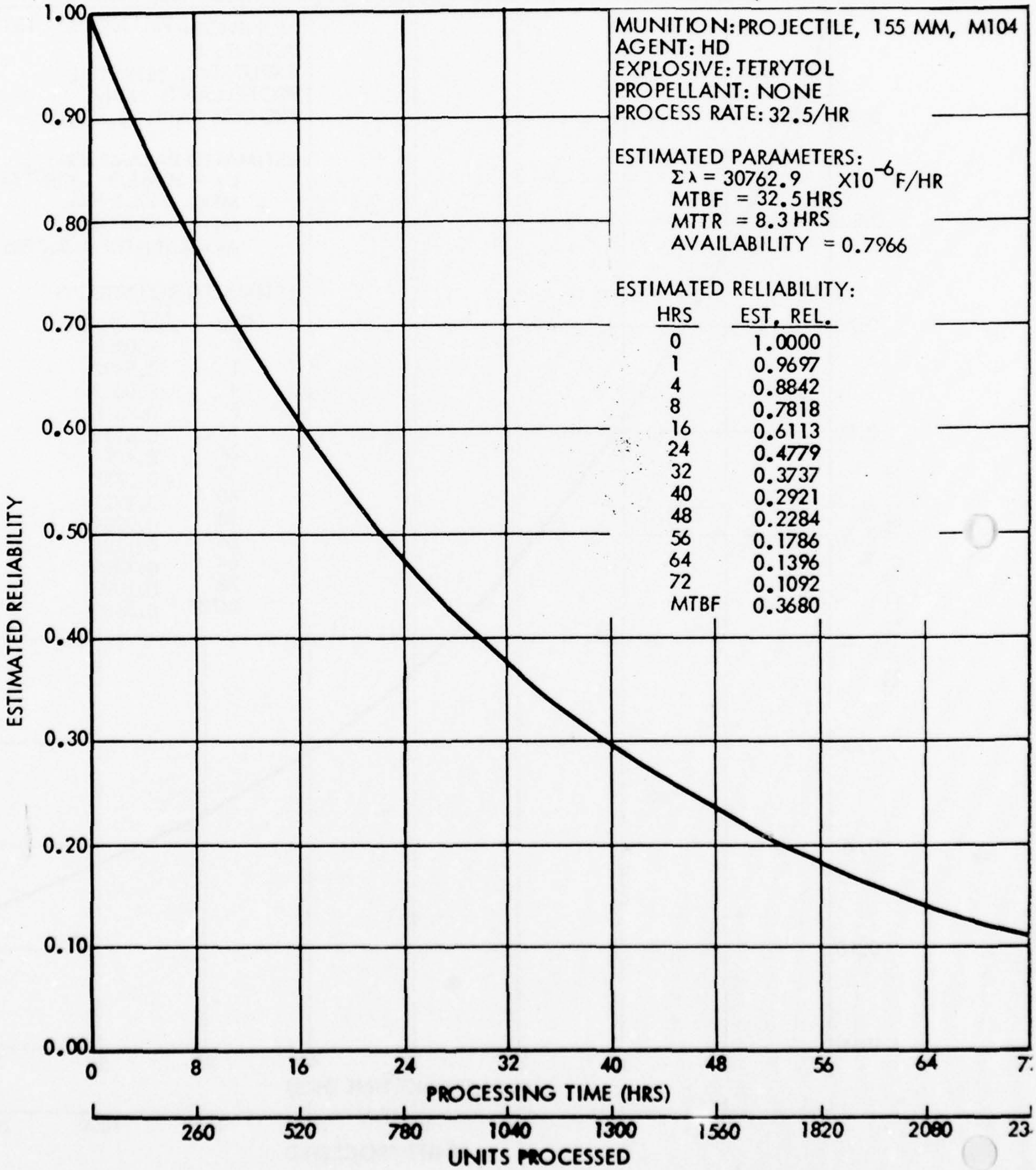


Reliability Estimation - CAMDS Munition Demilitarization



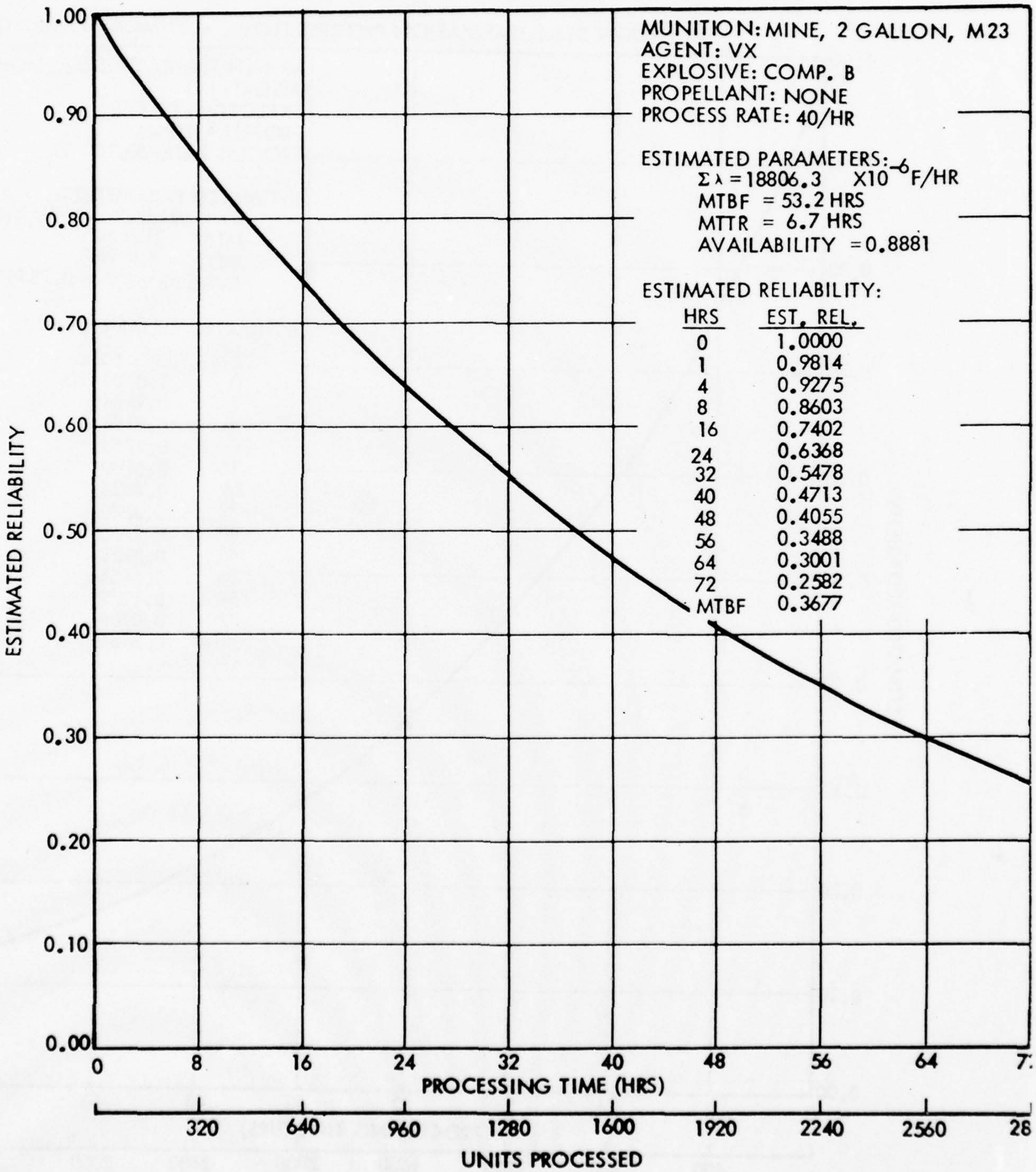
Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES, MUSTARD WITH BURSTERS

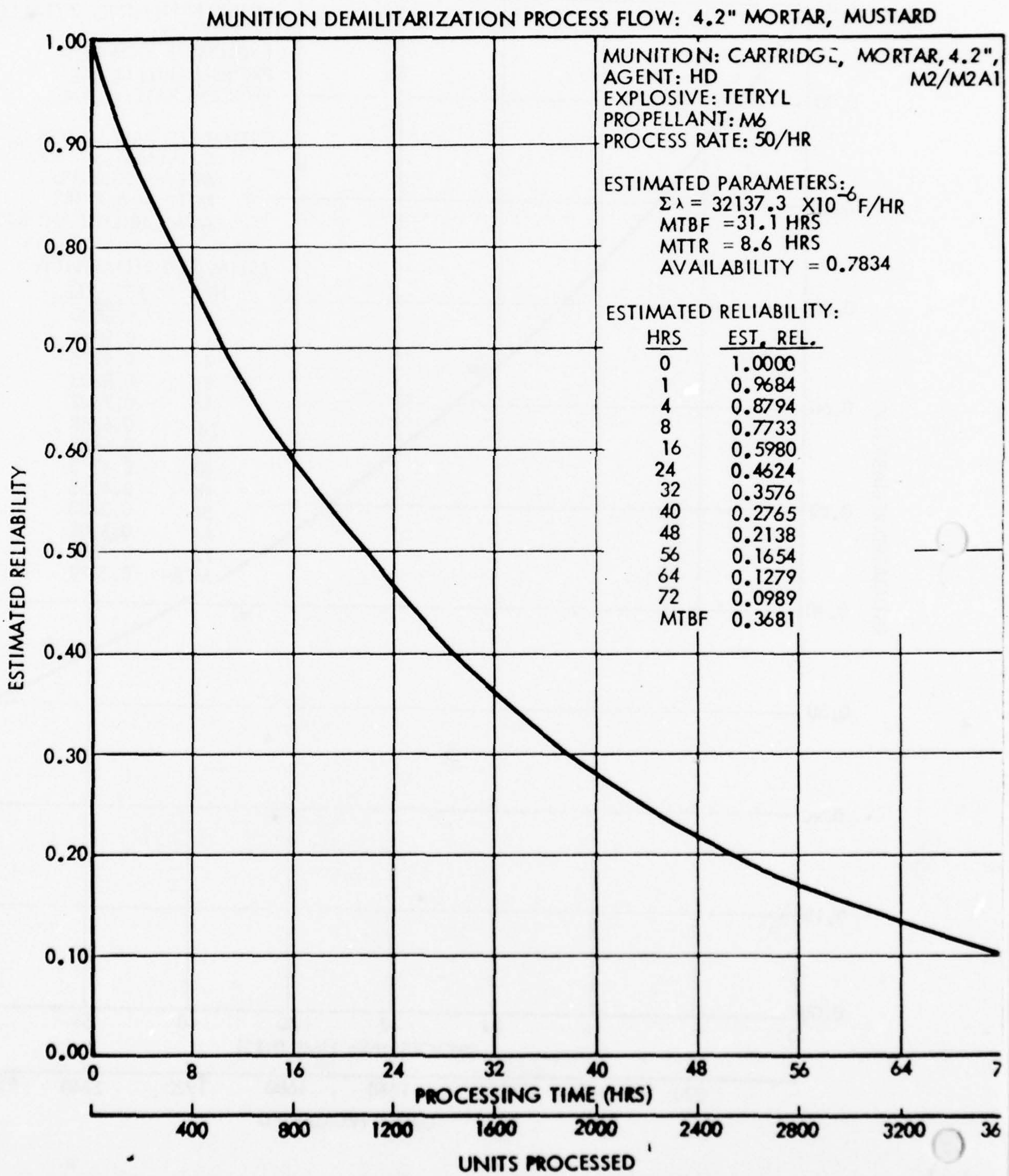


Reliability Estimation - CAMDS Munition Demilitarization

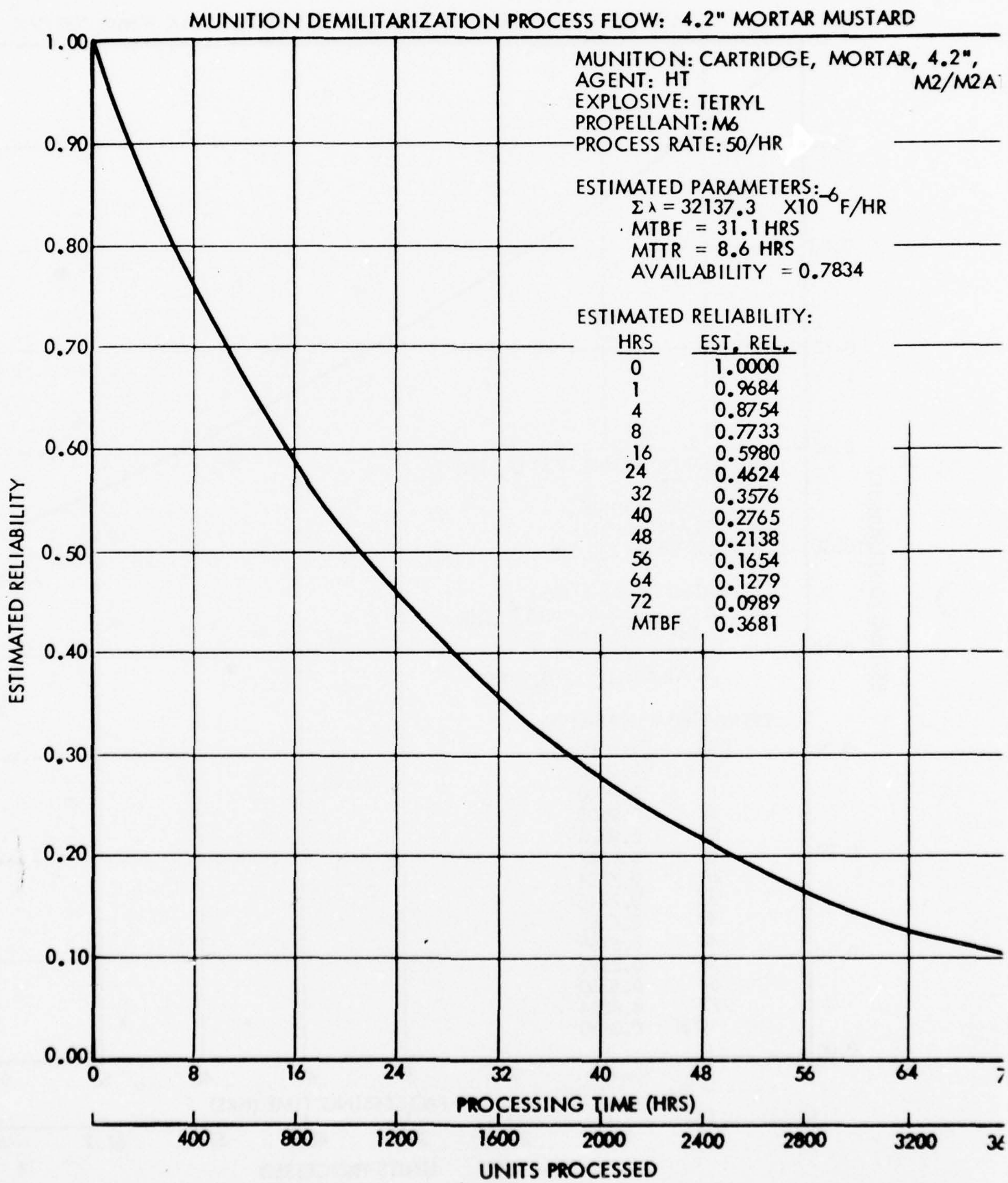
MUNITION DEMILITARIZATION PROCESS FLOW: M 23 MINE, VX



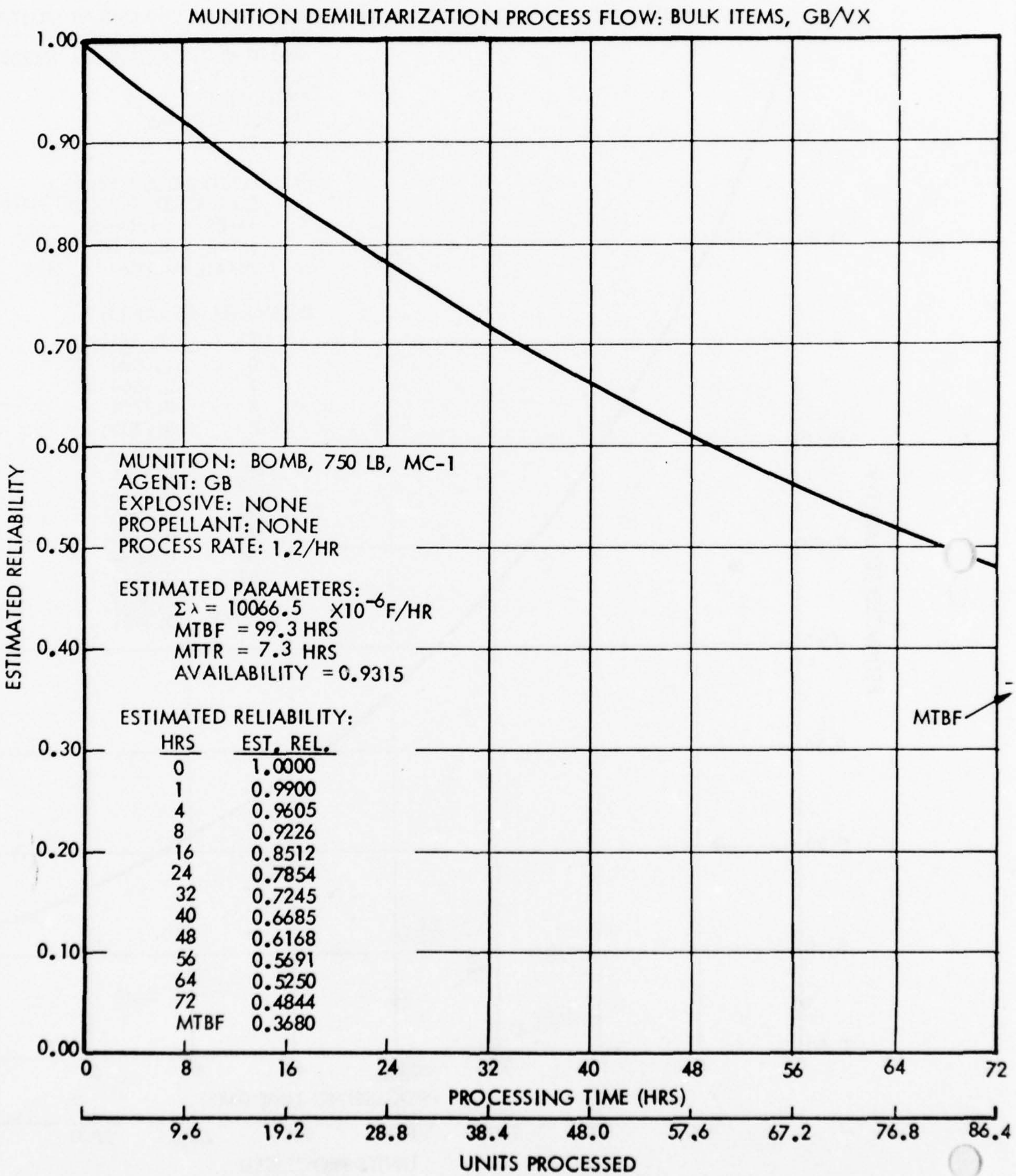
Reliability Estimation - CAMDS Munition Demilitarization



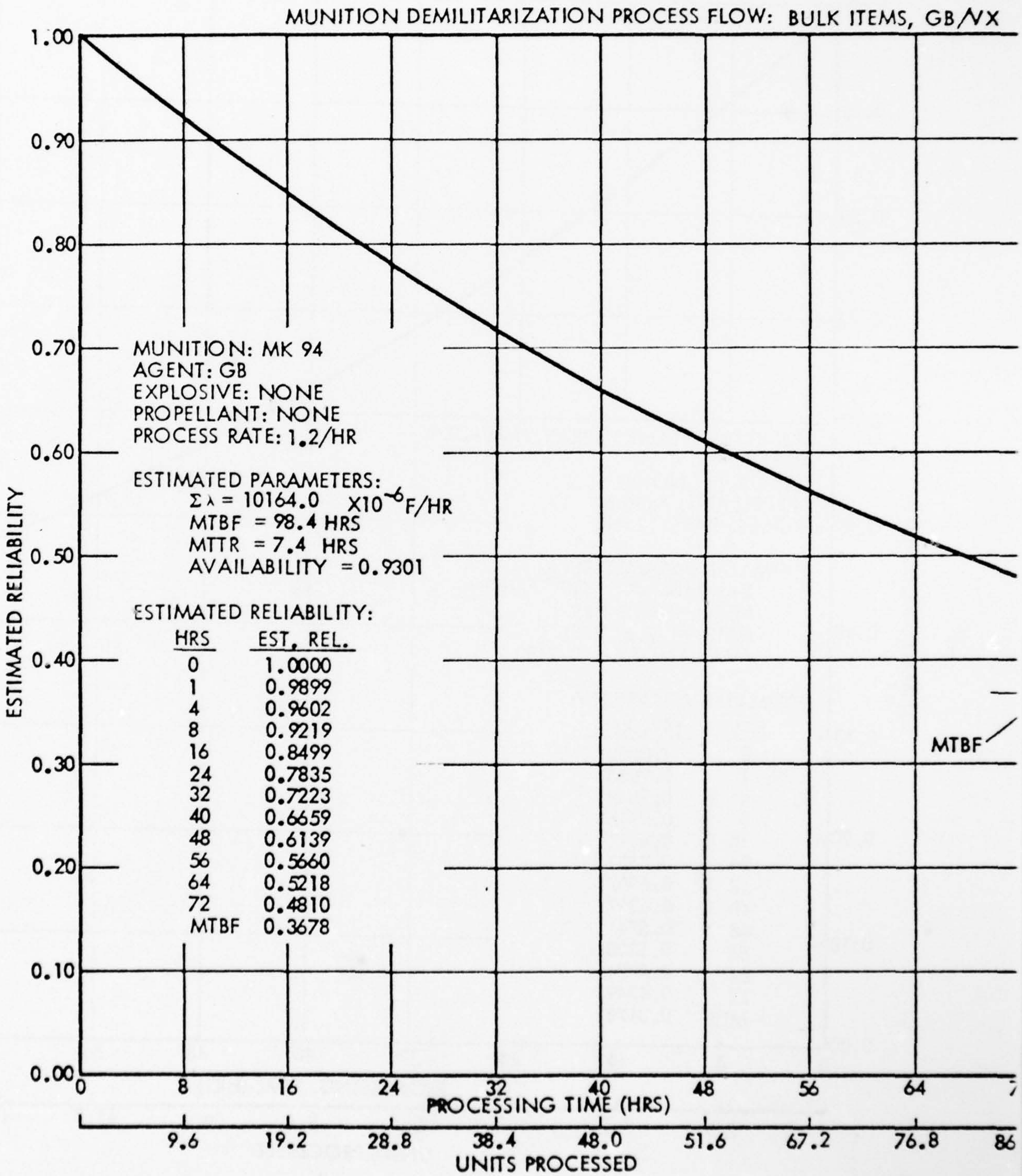
Reliability Estimation - CAMDS Munition Demilitarization



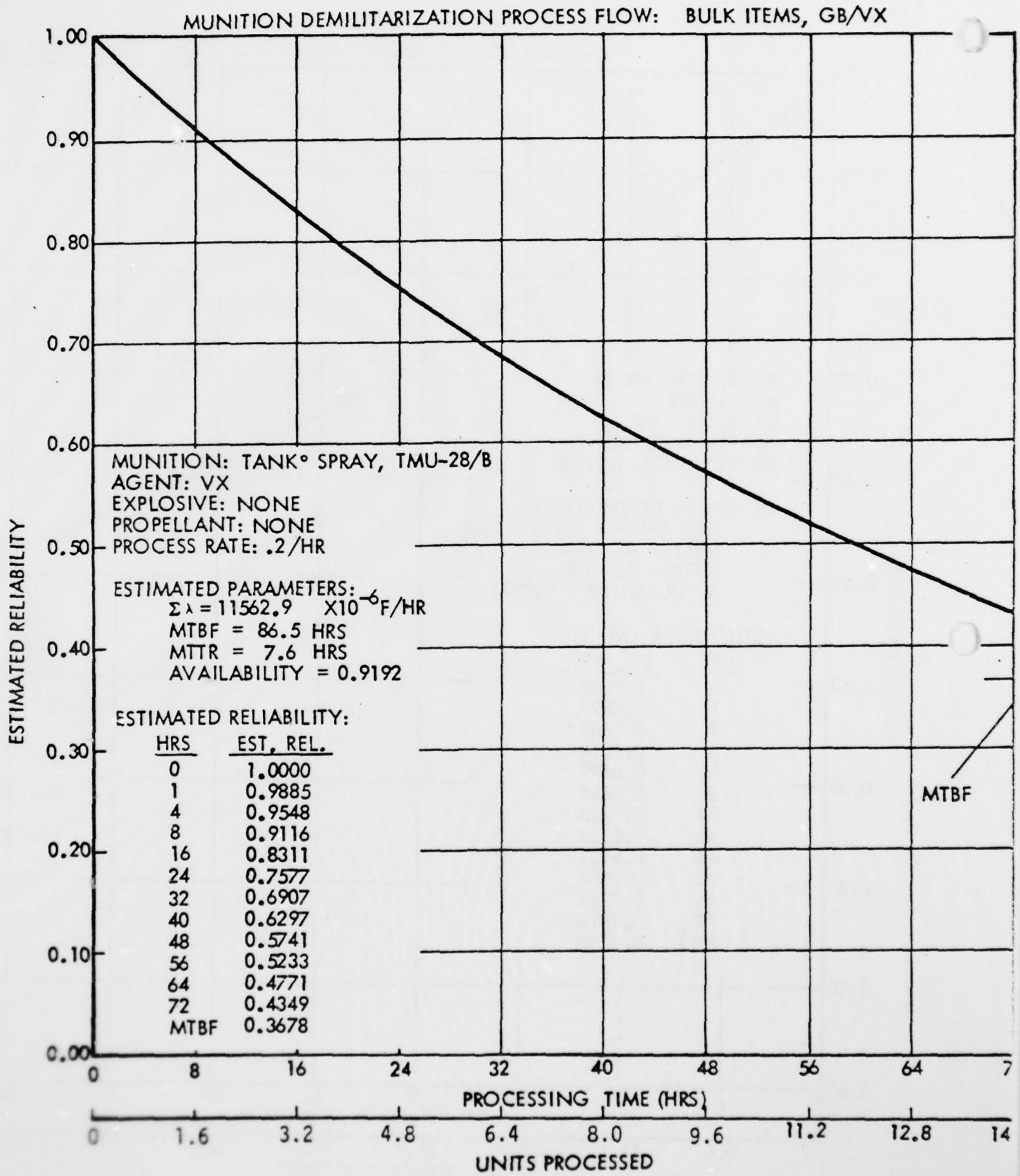
Reliability Estimation - CAMDS Munition Demilitarization



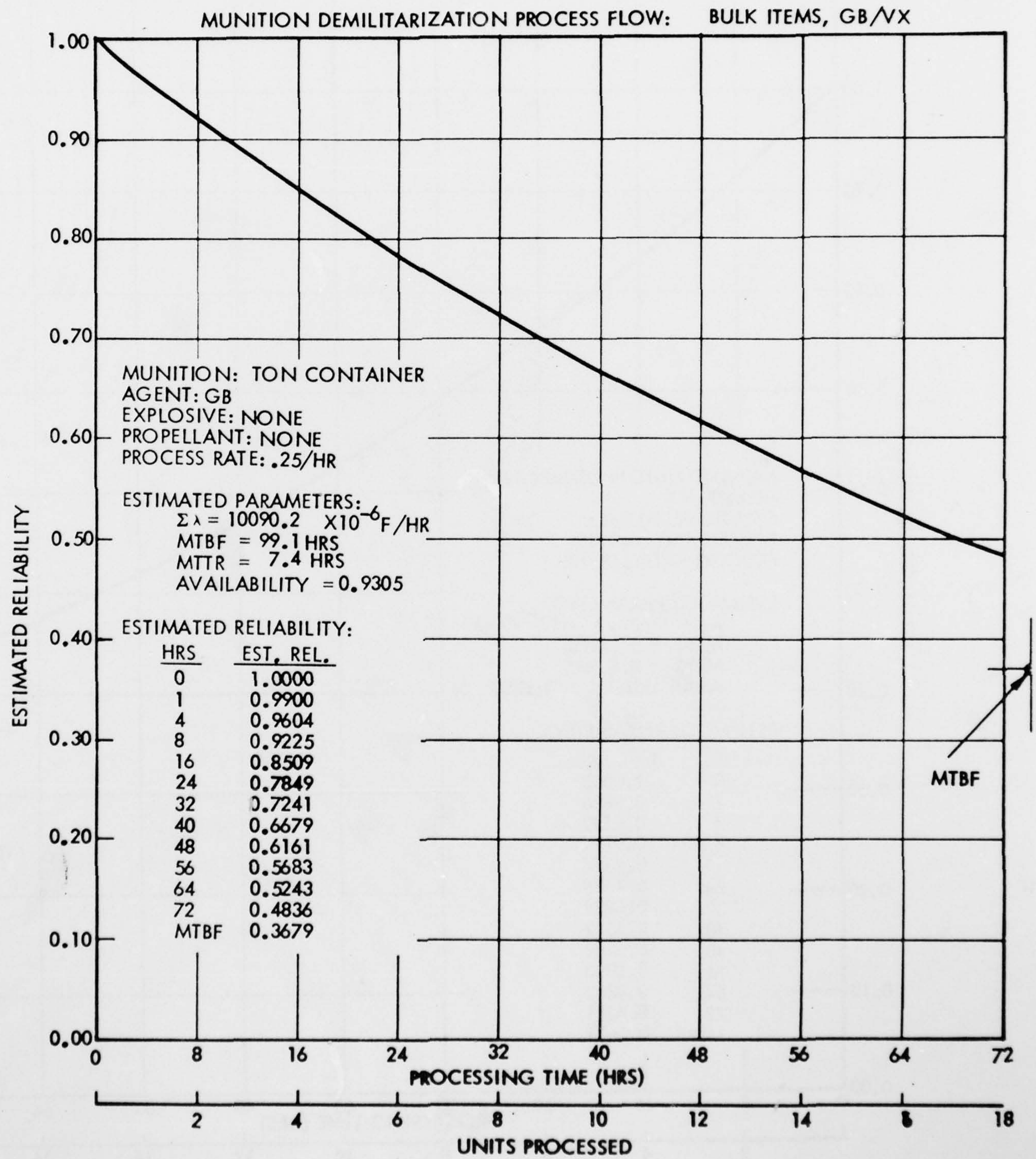
Reliability Estimation - CAMDS Munition Demilitarization



Reliability Estimation - CAMDS Munition Demilitarizarion

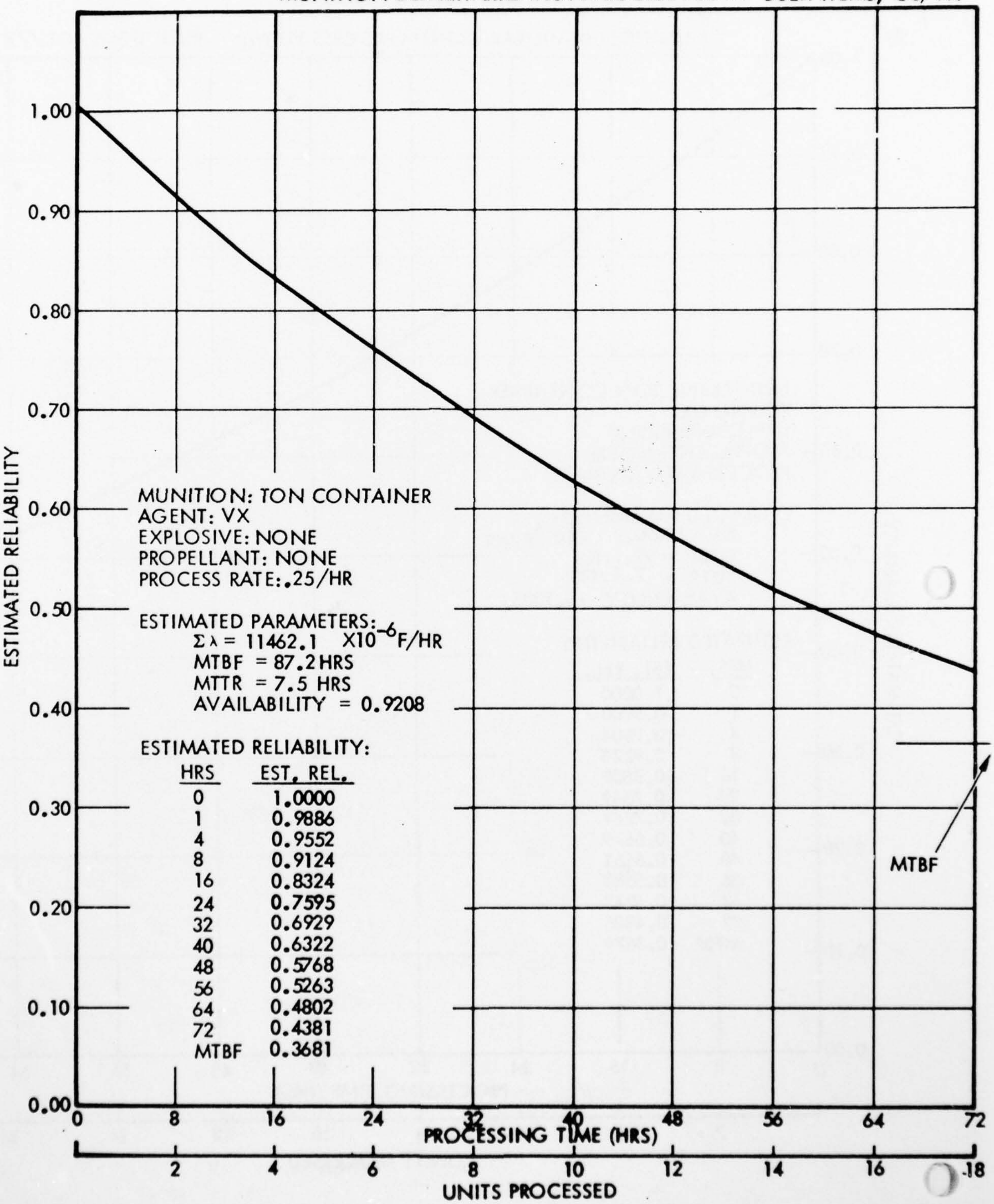


Reliability Estimation - CAMDS Munition Demilitarization

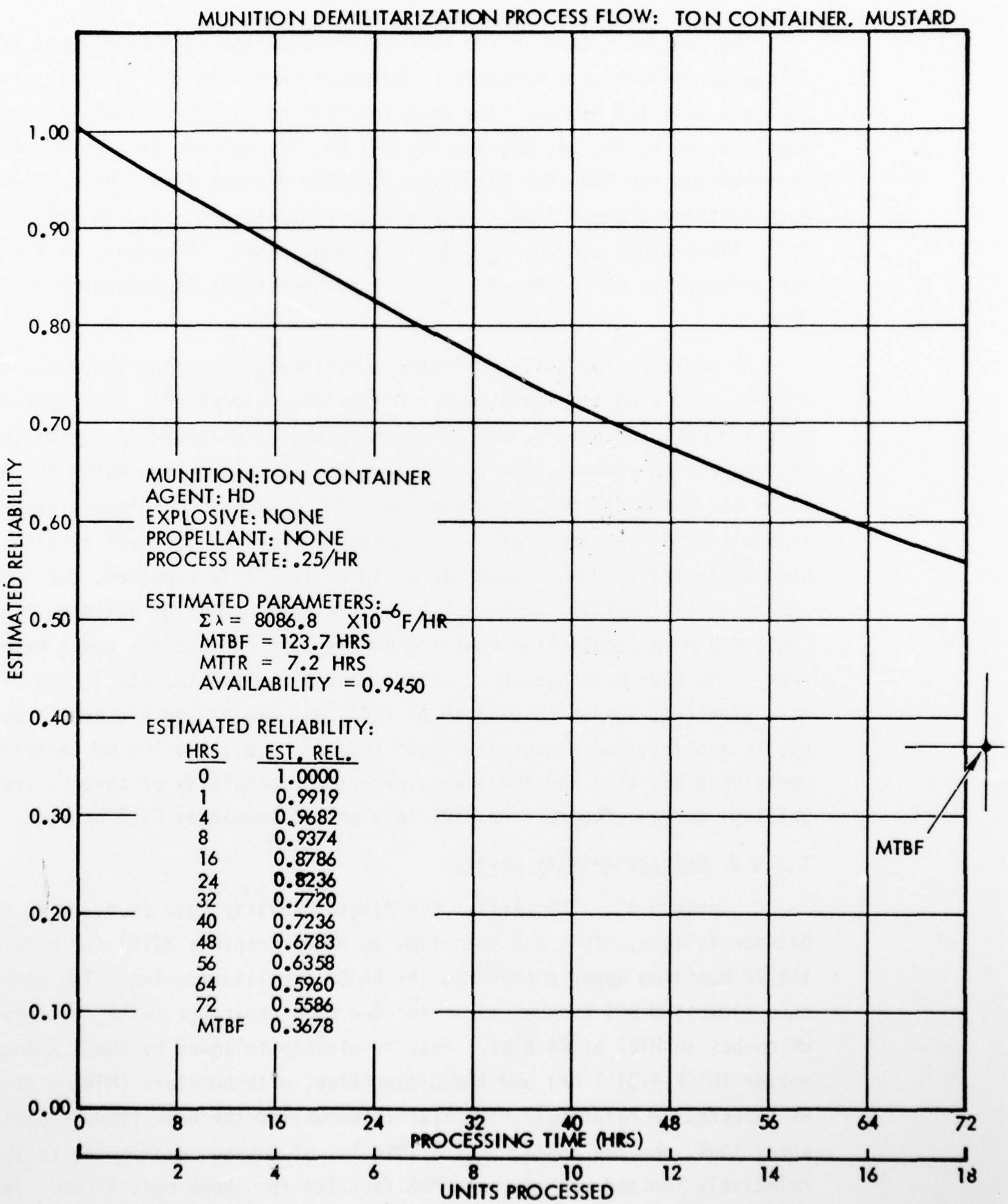


Reliability Estimation - CAMDS Munition Demilitarization

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX



Reliability Estimation - CAMDS Munition Demilitarization



Reliability Estimation -CAMDS Munition Demilitarization

The remaining term in the reliability equation (t = an element of time in hours) is left as a variable. The equation is plotted in this section for each munition process flow as a function of t. The values of t chosen are 0, 1, 4, 8, 16, 24, 32, 40, 48, 56, 64, 72, and the number of hours representing the MTBF for the given munition process flow. Also given for each munition process flow is the number of units processed in the hours "t". These plots are shown in the preceding pages. A summary plot showing the probability of success for all the process flows is presented in Figure 5-7.

As would be logically expected, the figures show that the munition process involving the least number of Building Blocks (8), the least complicated Building Blocks, one of the more easily disposed of agents (mustard), and one of the slowest (low-cyclic application) processing rates (0.25/hr), i.e., the ton container containing mustard, also has the highest expected probability of success (reliability) curve. The related MTBF is also the highest at 123.7 hours. Also, as would be logically expected, the figures show that the munition process involving a high number of Building Blocks (18), the more complicated Building Blocks (the ECC and its demil machine (PDM), the PPD, both hydraulic units, many MHE elements, etc.), one of the more difficult agents to dispose of (GB), and one of the highest (high-cyclic application) processing rates (50/hr), i.e., the 105 MM Cartridge containing GB, also has the lowest expected probability of success (reliability) curve. The related MTBF is also the lowest at 24.6 hours.

5.2.4.2 Maintainability Levels

Table 5-3 summarizes the maintainability data (i.e., mean time between failure, MTBF; and mean time to repair/replace MTTR) for each of the 22 munition types considered for CAMDS demilitarization. The worst case (lowest MTBF) is seen to be for the M360 cartridge (with burster) which has an MTBF of 24.6 hr. This is closely followed by the 4.2 inch mortar (MTBF = 31.1 hr) and the projectiles, with bursters (MTBF = 32.5). As expected, a relatively high MTBF is shown for the bulk items (bombs, spray tank, and ton containers). This is, of course, attributed to the relatively limited use of the CAMDS facility for these bulk items. In the case of the item showing the highest MTBF (123.7 hr), ton containers with mustard, delivery of the munition is made directly to the metal parts furnace which along with the agent destruction system comprise the only two major Building Blocks utilized for this item. In contrast, the M360 cartridge fully utilizes every major Building Block including both furnace systems (except, of course, other specialized demil machinery).

With regard to mean time to repair/replace (MTTR), it is of interest to note that while the MTTR shows quite a variation from Building Block to Building Block (a range of approximately 2 to 13 hours), the variation is relatively small with regard to munition process flow. That is, the average MTTR for the munitions of Table 5-3 is 7.76 hours with a standard deviation of 0.532 hour (6.9 percent).

5.2.4.3 Availability Results

The total system availability, for each munition type process flow, may be found in Table 5-4. The system availability, A, is defined as:

$$A = \frac{\text{Uptime}}{\text{Uptime} + \text{Downtime}} \quad \text{or} \quad A = \frac{1}{1 + \frac{\text{MTTR}}{\text{MTBF}}},$$

where: Uptime = MTBF (Mean Time Between Failures)
Downtime = MTTR (Mean Time to Repair/Replace)

thus, a high availability (approaching 1.0) is desirable, maximizing production rate and minimizing system downtime. Since the MTTRs (see Table 5-3) are relatively constant by munition type, the availability varies nearly proportional to MTBF. (In fact, except for slight variations at the extremes, the approximate empirical relationship $A = 0.49\ (\text{MTBF})^{0.142}$ seems valid.) Because of this the same munitions that yielded the low MTBF (i.e., M360 cartridge with burster) also produce the lowest availability of 74 percent. The highest availability figure was 94.5 percent for processing the ton container containing mustard. The next to last column of Table 5-4 shows a predicted production rate that is obtained by multiplying the nominal rate by the availability for each munition process. These predicted rates, of course, are based upon the Reliability and Maintainability Study performed only and do not include factors for such external items as transportation, weather, etc. (These items will be considered in Phase 3, however.)

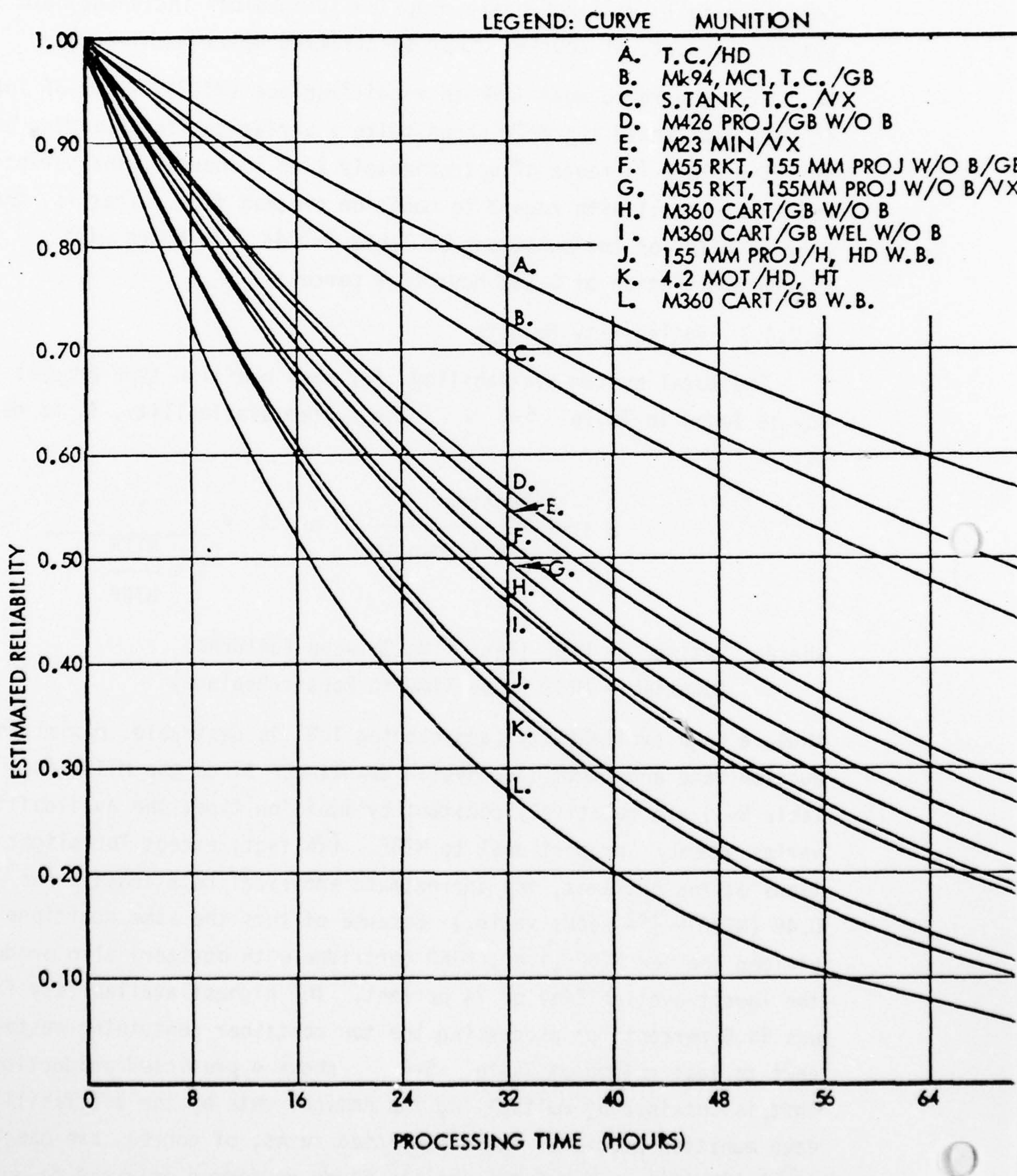


Figure 5-7. Summary of Reliability Estimation by Munition Type

Table 5-3. Total Process Maintainability by Munition Type

	Munition	Agent	Explosive	Propellent	Rate	MTBF (hr)	MTTR (hr)	Remarks
1.	M55 Rocket 115mm	GB	Comp B	M28	20/hr	48.5	8.2	
2.	M55 Rocket 115mm	VX	Comp B	M28	20/hr	45.5	8.2	
3.	Cartridge 105mm M360 w/o burster)	GB	--	--	50/hr	41.9	7.9	
4.	Cartridge 105mm M360 (w/o burster)	GB	--	--	50/hr	40.9	8.0	Welded Burster Well
5.	Projectile 155 mm M121A1 (w/o burster)	GB	--	--	32.5/hr	48.7	7.5	
6.	Projectile 155mm M121 (w/o burster)	GB	--	--	32.5/hr	48.7	7.5	
7.	Projectile 155mm M121 (w/o burster)	GB	--	--	32.5/hr	47.8	7.5	Welded Burster Well
8.	Projectile 155mm M122 (w/o burster)	GB	--	--	32.5/hr	48.7	7.5	
9.	Projectile 8 in. M426 (w/o burster)	GB	--	--	20/hr	55.9	7.2	
10.	Projectile 155mm M121A1 (w/o burster)	VX	--	--	32.5/hr	45.6	7.6	
11.	Cartridge 105mm M360 (w. burster)	GB	Tetrytol	M1	50/hr	24.6	8.7	
12.	Projectile 155mm M110 (w. burster)	H	Tetrytol	--	32.5/hr	32.5	8.3	
13.	Projectile 155mm M104 (w. burster)	4D	Tetrytol	--	32.5/hr	32.5	8.3	
14.	Mine, 2 gal., M23	VX	Comp B	--	40/hr	53.2	6.7	
15.	Cartridge, Mortar, 4.2 in. M2/M2A1	HD	Tetryl	M6	50/hr	31.1	8.6	

Table 5-3 (Continued). Total Process Maintainability by Munition Type

	Munition	Agent	Explosive	Propellent	Rate	MTBF (hr)	MTTR (hr)	Remarks
16.	Cartridge, Mortar, 4.2 in. M2/M2A1	HD	Tetryl	M6	50/hr	31.1	8.6	
17.	Bomb, 750#, MC-1	GB	--	--	1.2/hr	99.3	7.3	
18.	Bomb, MK94	GB	--	--	1.2/hr	98.4	7.4	
19.	Tank, Spray, TMU-281B	VX	--	--	02/hr	86.5	7.6	
20.	Ton Container	GB	--	--	0.25/hr	99.1	7.4	
21.	Ton Container	VX	--	--	0.25/hr	87.2	7.5	
22.	Ton Container	HD	--	--	0.25/hr	123.7	7.2	

Table 5-4. Total Process Availability by Munition Type

	MUNITION	AGENT	EXPLOSIVE	PROPELLANT	TARGET RATE	AVAILABILITY	PREDICTED RATE	REMARKS
1.	M55 Rocket 115mm	GB	COMP B	M28	20/Hr	.8554	17.1	
2.	M55 Rocket 115mm	VX	COMP B	M28	20/Hr	.8473	16.9	
3.	Cartridge 105mm M360 (w/o Burster)	GB			50/Hr	.8414	42.0	
4.	Cartridge 105mm M360 (w/o Burster)	GB			50/Hr	.8364	41.8	Welded Burster Well
5.	Projectile 155mm M121A1 (w/o Burster)	GB			32.5/Hr	.8665	28.2	
6.	Projectile 155mm M121 (w/o Burster)	GB			32.5/Hr	.8665	28.2	
7.	Projectile 155mm M121 (w/o Burster)	GB			32.5/Hr	.8644	28.1	Welded Burster Well
8.	Projectile 155mm M122 (w/o Burster)	GB			32.5/Hr	.8665	28.2	
9.	Projectile 8 in. M426 (w/o Burster)	GB			20/Hr	.8859	17.7	
10.	Projectile 155mm M121A1 (w/o Burster)	VX			32.5/Hr	.8571	27.9	
11.	Cartridge 105mm M370 (w/Burster)	GB	TETRYTOL	M1	50/Hr	.7387	36.9	
12.	Projectile 155mm M110 (w/Burster)	H	TETRYTOL		32.5/Hr	.7966	25.9	
13.	Projectile 155mm M104 (w/Burster)	HD	TETRYTOL		32.5/Hr	.7966	25.9	
14.	Mine, 2 Gallon, M23	VX	COMP B		40/Hr	.8881	35.5	
15.	Cartridge, Mortar, 4.2 in., M2/M2A1	HD	TETRYL	M6	50/Hr	.7834	39.2	
16.	Cartridge, Mortar, 4.2 in., CM2/M2A1	HT	TETRYL	M6	50/Hr	.7834	39.2	
17.	Bobm, 750#, MC-1	GB			1.2/Hr	.9315	1.12	
18.	Bomb, MK94	GB			1.2/Hr	.9301	1.12	
19.	Tank, Spray, TMU-28/B	VX			0.2/Hr	.9192	.18	
20.	Ton Container	GB			0.25/Hr	.9305	.23	
21.	Ton Container	VX			0.25/Hr	.9208	.23	
22.	Ton Container	HD			0.25/Hr	.9450	.24	

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: M55 ROCKET, GB/VX

MUNITION: Rocket, 115mm, M55 Agent: GB Exp: Comp B Prop: M28 Process Rate: 20/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAILABIL
1.	UPA	UNPACK AREA		NEG	N/A	NEG	N/A	≈ 1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		510.128	1960	6125.587	12.01	0.99
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.98
5.	MPF	METAL PARTS FURNACE	NA					
6.	RDM	ROCKET DEMIL MACHINE		2654.534	377	32662.332	12.30	0.96
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG	N/A	NEG	N/A	≈ 1.0
9.	EHM	ECC HYDRAULICS		1836.106	545	18514.839	10.08	0.98
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.97
14.	ETS	EXPLOSIVE TREATMENT SYSTEM		393.0	2539	2246.8	5.70	0.99
15.	PDM	PROJECTILE DEMIL MACHINE	NA					
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA					
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.99
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA					
22.	MHE	MATERIAL HANDLING EQUIPMENT		4601.758	217	53437.995	11.61	0.94
23.	FIL	FILTER SYSTEM		636.5	1571	4512.6	7.09	0.99
24.	MOR	MORTAR DEMIL MACHINE	NA					
25.	MIN	MINE DEMIL MACHINE	NA					
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.99
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.99
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.99
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.99
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.99
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		20634.9	48.5	168331.5	8.2	0.855

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: M55 ROCKET, GB/VX

MUNITION: Rocket, 115mm, M55 Agent: VX Exp: Comp B Prop: M28 Process Rate: 20/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL- ABILI
1.	UPA	UNPACK AREA		NEG	N/A	NEG	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		510.128	1960	6125.587	12.01	0.9939
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE	NA					
6.	RDM	ROCKET DEMIL MACHINE		2654.534	377	32662.332	12.30	0.9684
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG	N/A	NEG	N/A	≈1.0
9.	EHM	ECC HYDRAULICS		1836.106	545	18514.839	10.08	0.9818
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM		393.9	2539	2246.8	5.70	0.9978
15.	PDM	PROJECTILE DEMIL MACHINE	NA					
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA					
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA					
22.	MHE	MATERIAL HANDLING EQUIPMENT		4601.758	217	53437.995	11.61	0.9493
23.	FIL	FILTER SYSTEM		636.5	1571	4512.6	7.09	0.9955
24.	MOR	MORTAR DEMIL MACHINE	NA					
25.	MIN	MINE DEMIL MACHINE	NA					
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	229.31	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2782.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		22001.8	45.5	180558.6	8.2	0.8473

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT .

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: Cartridge, 105mm, M360 Agent: GB Exp: None Prop: None Process Rate: 50/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABIL
1.	UPA	UNPACK AREA		NEG	N/A	NEG	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA					
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA					
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.96
6.	RDM	ROCKET DEMIL MACHINE	NA					
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		4328.878	231	43193.280	9.98	0.95
9.	EHM	ECC HYDRAULICS	NA					
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.97
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA					
15.	PDM	PROJECTILE DEMIL MACHINE	NA					
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		5133.993	195	53120.012	10.35	0.94
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	.99
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA					
22.	MHE	MATERIAL HANDLING EQUIPMENT		1920.052	521	17048.666	8.88	0.98
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.99
24.	MOR	MORTAR DEMIL MACHINE	NA					
25.	MIN	MINE DEMIL MACHINE	NA					
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.99
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.99
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.99
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.99
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.99
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		23881.5	41.9	189684.6	7.9	0.84

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES,GB/VX WITHOUT BURSTERS

MUNITION: Cartridge, 105mm,M360 with Welded Burster Well — AGENT: GB — EXP: None — PROP: None — PROCESS R 50/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVA ABI
1.	UPA	UNPACK AREA		NEG	N/A	NEG	N/A	1.C
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	-
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	-
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.96
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	-
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		4328.878	231	43193.280	9.98	0.95
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	-
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.97
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	-
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	-
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		5693.613	176	57945.615	10.18	0.94
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.99
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	-
22.	MHE	MATERIAL HANDLING EQUIPMENT		1920.052	521	17048.666	8.88	0.98
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.99
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	-
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	-
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.99
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.99
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.99
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.99
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.99
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		24441.2	40.9	194510.2	8.0	0.83

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

AD-A062 678 TRW/ENVIRONMENTAL ENGINEERING DIV REDONDO BEACH CA F/G 15/2
RELIABILITY AND MAINTENANCE PROGRAM ANALYSIS RELIABILITY AND MA--ETC(U)
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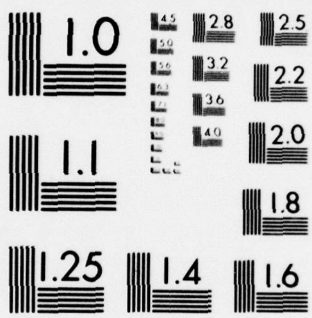
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MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES,GB/VX WITHOUT BURSTERS

MUNITION: Projectile, 155mm,M121A1 Agent: GB Exp: None Prop: None Process Rate: 32.5/h

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVA ABI
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.99
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	-
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	-
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.96
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	-
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2874.761	348	28797.522	10.02	0.97
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	-
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.97
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	-
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	-
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3539.685	283	36571.318	10.33	0.96
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.99
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	-
22.	MHE	MATERIAL HANDLING EQUIPMENT		1386.589	721	11925.633	8.60	0.98
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.99
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	-
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	-
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.99
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.99
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.99
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.99
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		20540.7	48.7	154202.0	7.5	0.8

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: Projectile, 155mm, M121 With Welded Burster Well — AGENT: GB — EXP: None — PROP: None — PROCESS RAT[E] 32.5/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAILABIL
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.99
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	-
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	-
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.96
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	-
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2874.761	348	28797.522	10.02	0.97
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	-
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.97
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	-
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	-
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3903.438	256	39707.961	10.71	0.96
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.99
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	-
22.	MHE	MATERIAL HANDLING EQUIPMENT		1386.589	721	11925.633	8.60	0.98
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.99
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	-
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	-
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.99
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.99
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.99
31.	COM	COMMUNICATIONS		325.296	2738	1095.888	3.0	0.99
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.99
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		20904.4	47.8	157338.6	7.5	0.86

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: Projectile, 155mm, M122 Agent: GB Exp: None Prop: None Process Rate: 32.5/h

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AV. AB
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.9
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	-
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	-
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	-
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2874.761	348	28797.522	10.02	0.9
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	-
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	-
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	-
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3539.685	283	36571.318	10.33	0.9
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	-
22.	MHE	MATERIAL HANDLING EQUIPMENT		1386.589	721	[illegible]25.633	8.60	0.9
23.	FIL	FILTER SYSTEM		636.4	1571	4[illegible]12.6	7.09	0.9
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	-
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	-
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		20540.7	48.7	154202.0	7.5	0.

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

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MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: Projectile, 8", M426 Agent: GB Exp: None Prop: None Process Rate: 20/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILIT
1.	UPA	UNPACK AREA		153.506	6514	371.708	2.42	0.9996
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		1836.106	545	18514.839	10.08	0.9818
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9768
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		2400.892	417	24750.822	10.31	0.9758
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		1005.544	994	8766.324	8.22	0.9918
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.9955
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		17894.7	55.9	128226.3	7.2	0.8859

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

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MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES, GB/VX WITHOUT BURSTERS

MUNITION: Projectile, 155mm, M121A1 Agent: VX Exp: None Prop: None Process Rate: 32.5/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.9994
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2374.761	348	28797.522	10.02	0.9720
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3539.685	283	36571.318	10.33	0.9647
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		1386.589	721	11925.633	8.60	0.9882
23.	FIL	FILTER SYSTEM		636.4	1571	4512.6	7.09	0.9955
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.880	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		21912.6	45.6	166429.1	7.6	0.8571

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

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MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES/CARTRIDGES GB/VX WITH BURSTERS

105mm, M360 Agent: GB Exp: Tetrytol Prop: M1

MUNITION: PROJECTILES/CARTRIDGES GB/VX WITH BURSTERS

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA		NEG.	N/A	NEG.	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		1138.286	879	13344.927	11.72	0.9868
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		4328.878	231	43193.280	9.98	0.9586
9.	EHM	ECC HYDRAULICS		4328.878	231	43193.280	9.98	0.9586
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9768
14.	ETS	EXPLOSIVE TREATMENT SYSTEM		393.9	2539	2246.8	5.70	0.9978
15.	PDM	PROJECTILE DEMIL MACHINE		4470.142	224	56525.312	12.65	0.9465
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		5133.993	195	53120.012	10.35	0.9496
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		5426.815	184	43942.101	8.10	0.9579
23.	FIL	FILTER SYSTEM		970.3	1031	6879.4	7.09	0.9932
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1085.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		40573.5	24.6	351672.4	8.7	0.7387

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES, MUSTARD WITH BURSTERS

MUNITION: Projectile, 155mm, M110 Agent: H Exp: Tetrytol Prop: None Process Rate: 32.5/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.9994
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		796.688	1255	9337.351	11.72	0.9907
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2874.761	348	28797.522	10.02	0.9720
9.	EHM	ECC HYDRAULICS		2874.761	348	28797.522	10.02	0.9720
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		2248.3	445	14483.4	6.44	0.9857
14.	ETS	EXPLOSIVE TREATMENT SYSTEM		393.9	2539	2246.9	5.70	0.9978
15.	PDM	PROJECTILE DEMIL MACHINE		2948.017	339	37250.544	12.64	0.9641
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3025.018	331	31661.549	10.47	0.9693
19.	CDS	CENTRAL DECON SYSTEM	NA	--	--	--	--	--
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		3688.244	271	30547.389	8.28	0.9704
23.	FIL	FILTER SYSTEM		970.3	1031	6879.4	7.09	0.9932
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		23.908	41827	64.232	2.69	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	229.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		30762.9	32.5	254793.3	8.3	0.7966

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

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MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: PROJECTILES, MUSTARD WITH BURSTERS

MUNITION: Projectile, 155 mm, M104 Agent: HD Exp: Tetrytol Prop: None Process Rate 32.5/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILIT
1.	UPA	UNPACK AREA		241.039	4149	584.843	2.43	0.9994
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		796.688	1255	9337.351	11.72	0.9907
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		2874.761	348	28797.522	10.02	0.9720
9.	EHM	ECC HYDRAULICS		2874.761	348	28797.522	10.02	0.9720
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		2248.3	445	14483.4	6.44	0.9857
14.	ETS	EXPLOSIVE TREATMENT SYSTEM		393.9	2539	2246.8	5.70	0.9978
15.	PDM	PROJECTILE DEMIL MACHINE		2948.017	339	37250.544	12.64	0.9641
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		3025.318	331	31661.549	10.47	0.9693
19.	CDS	CENTRAL DECON SYSTEM	NA	--	--	--	--	--
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		3688.244	271	30547.339	8.28	0.9704
23.	FIL	FILTER SYSTEM		970.3	1031	6879.4	7.09	0.9932
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		23.908	41827	64.232	2.69	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		30762.9	32.5	254793.3	8.3	0.7966

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: M23 MINE, VX

MUNITION: Mine, 2 Gallon, M23 Agent: VX Exp: Comp B Prop: None Process Rate: 40/h

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILIT
1.	UPA	UNPACK AREA		NEG	N/A	NEG.	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		802.360	1246	9556.234	11.91	0.9905
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE	NA	--	--	--	--	--
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG.	N/A	NEG.	N/A	≈1.0
9.	EHM	ECC HYDRAULICS		3497.954	286	11655.711	10.00	0.9662
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA	--	--	--	--	--
19.	CDS	CENTRAL DECON SYSTEM	NA	--	--	--	--	--
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		59.586	16783	361.134	6.06	0.9996
23.	FIL	FILTER SYSTEM		553.2	1808	3925.4	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE		2775.954	360	38759.304	13.96	0.9627
26.	PIP	PIPING		50.775	19695	149.496	2.94	0.9998
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		18806.3	53.2	126147.0	6.7	0.8881

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: 4.2" MORTAR, MUSTARD

MUNITION: Cartridge, Mortar, 4.2", M2/M2A1 Agent: HD Exp: Tetryl Prop: M6 Process Rate: 60/

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILIT
1.	UPA	UNPACK AREA		NEG.	N/A	NEG.	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		1074.292	931	12350.705	11.50	0.9878
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE		4380.3	228	38376	8.77	2.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		4328.878	231	43193.280	9.98	0.9586
9.	EHM	ECC HYDRAULICS		4328.878	231	43193.280	9.98	0.9586
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		2248.3	445	14483.4	6.44	0.9857
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		4342.658	230	45566.522	10.49	0.9564
19.	CDS	CENTRAL DECON SYSTEM	NA	--	--	--	--	--
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		3303.338	303	33099.942	10.02	0.9680
23.	FIL	FILTER SYSTEM		887.0	1127	6291.8	7.09	0.9937
24.	MOR	MORTAR DEMIL MACHINE		922.44	1084	13027.7	14.12	0.9871
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		23.908	41827	64.232	2.69	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.510	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.898	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		32137.3	31.1	275413.6	8.6	0.7834

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT .

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: 4.2" MORTAR, MUSTARD

MUNITION: Cartridge, Mortar, 4.2", M2/M2A1 Agent: HT Exp: Tetryl Prop: M6 Process Rate: 50

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAILABILITY
1.	UPA	UNPACK AREA		NEG	N/A	NEG	N/A	≈1.0
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE		1074.292	931	12350.705	11.50	0.9878
4.	DFS	DEACTIVATION FURNACE SYSTEM		2520.1	397	17417.3	6.91	0.9829
5.	MPF	METAL PARTS FURNACE		4380.3	228	33396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		4328.878	231	43193.280	9.98	0.9586
9.	EHM	ECC HYDRAULICS		4328.878	231	43193.280	9.98	0.9586
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		2248.3	445	14483.4	6.44	0.9857
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE		4342.658	230	45566.522	10.49	0.9564
19.	CDS	CENTRAL DECON SYSTEM	NA	--	--	--	--	--
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA	--	--	--	--	--
22.	MHE	MATERIAL HANDLING EQUIPMENT		3303.338	303	33099.942	10.02	.9680
23.	FIL	FILTER SYSTEM		887.0	1127	6391.8	7.09	0.9937
24.	MOR	MORTAR DEMIL MACHINE		922.44	1084	13027.7	14.12	0.9871
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		23.908	41827	64.232	2.69	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM		2787.872	359	5973.744	2.14	0.9941
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		32137.3	31.1	275413.6	8.6	0.7834

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: Bomb, 750#, MC-1 Agent: GB Exp: None Prop: None Process Rate 1.2/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NA	--	--	--	--	--
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG.	N/A	NEG.	N/A	≈1.0
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9768
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA	--	--	--	--	--
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY		462.9	2160	3979.8	8.60	0.9960
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA	--	--	--	--	--
23.	FIL	FILTER SYSTEM		553.1	1808	3925.0	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		26.891	37187	87.644	8.26	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA	--	--	--	--	--
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		10066.5	99.3	73679.2	7.3	0.9315

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: Bomb, MK94 Agent: GB Exp: None Prop: None Process Rate: 1.2/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NA	--	--	--	--	--
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG.	N/A	NEG	N/A	≈1.0
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9768
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA	--	--	--	--	--
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY		560.4	1784.4	5028.7	8.97	0.[illegible]50
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA	--	--	--	--	[illegible]
23.	FIL	FILTER SYSTEM		553.1	1803	3925.0	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		26.891	37187	87.644	8.26	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.388	3.0	0.9987
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA	--	--	--	--	--
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		10164.0	98.4	74728.1	7.4	0.9301

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: Ton Container Agent: GB Exp: None Prop: None Process Rate: .25 hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILIT
1.	UPA	UNPACK AREA	NA	--	--	--	--	--
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG.	N/A	NEG.	N/A	1.0
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		3397.2	294	23765.9	7.00	0.9768
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA	--	--	--	--	--
19.	CDS	CENTRAL DECON SYSTEM		256.7	3396	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY		486.6	2055	4562.8	9.38	0.9955
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA	--	--	--	--	--
23.	FIL	FILTER SYSTEM		553.1	1808	3925.0	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		26.891	37187	87.644	3.26	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA	--	--	--	--	--
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		10090.2	99.1	74262.2	7.4	0.9305

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: Tank, Spray, TMU-28/B Agent: VX Exp: None Prop: None Process Rate: .2/hr

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NA	--	--	--	--	--
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA	--	--	--	--	--
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA	--	--	--	--	--
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA	--	--	--	--	--
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG.	N/A	NEG.	N/A	≈1.0
9.	EHM	ECC HYDRAULICS	NA	--	--	--	--	--
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA	--	--	--	--	--
15.	PDM	PROJECTILE DEMIL MACHINE	NA	--	--	--	--	--
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA	--	--	--	--	--
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY		587.4	1702	5644.2	9.61	0.994[illegible]
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA	--	--	--	--	--
23.	FIL	FILTER SYSTEM		553.1	1808	3925.0	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA	--	--	--	--	--
25.	MIN	MINE DEMIL MACHINE	NA	--	--	--	--	--
26.	PIP	PIPING		26.891	37187	87.644	3.26	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA	--	--	--	--	--
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		11562.9	86.5	87570.7	7.6	0.9192

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: BULK ITEMS, GB/VX

MUNITION: Ton Container Agent: VX Exp: None Prop: None Process Rate: .25/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NA					
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA					
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA					
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA					
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG	N/A	NEG	N/A	≈1.0
9.	EHM	ECC HYDRAULICS	NA					
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		4769.1	210	35993	7.55	0.9653
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA					
15.	PDM	PROJECTILE DEMIL MACHINE	NA					
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA					
19.	CDS	CENTRAL DECON SYSTEM		256.7	3896	1169.2	4.55	0.9988
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY		486.6	2055	4562.8	9.38	0.9955
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA					
23.	FIL	FILTER SYSTEM		553.1	1808	3925.0	7.10	0.9961
24.	MOR	MORTAR DEMIL MACHINE	NA					
25.	MIN	MINE DEMIL MACHINE	NA					
26.	PIP	PIPING		26.891	37187	87.644	3.26	0.9999
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA					
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		11462.1	87.2	86489.3	7.5	0.9208

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT .

NEG - NEGLIGIBLE

MUNITION AVAILABILITY PARAMETER SUMMARY

MUNITION DEMILITARIZATION PROCESS FLOW: TON CONTAINER, MUSTARD

MUNITION: Ton Container   Agent: HD   Exp: None   Prop: None   Process Rate: .25/hr.

NO.	ABV.	BUILDING BLOCK		Nλ	MTBF	NλTM	MTTR	AVAIL-ABILITY
1.	UPA	UNPACK AREA	NA					
2.	ECC	EXPLOSIVE CONTAINMENT CUBICLE	NA					
4.	DFS	DEACTIVATION FURNACE SYSTEM	NA					
5.	MPF	METAL PARTS FURNACE		4380.3	228	38396	8.77	0.9630
6.	RDM	ROCKET DEMIL MACHINE	NA					
7.	DUN	DUNNAGE INCINERATOR SYSTEM	NC					
8.	UTL	UTILITIES		NEG	NA	NEG	NA	≈1.0
9.	EHM	ECC HYDRAULICS	NA					
10.	CON	CONTROL MODULE	NC					
12.	PSC	PERSONNEL SUPPORT COMPLEX	NC					
13.	ADS	AGENT DESTRUCTION SYSTEM		2248.3	445	14483.4	6.44	0.9857
14.	ETS	EXPLOSIVE TREATMENT SYSTEM	NA					
15.	PDM	PROJECTILE DEMIL MACHINE	NA					
18.	PPD	PROJECTILE PULL AND DRAIN MACHINE	NA					
19.	CDS	CENTRAL DECON SYSTEM	NA					
20.	PDF	PROJECTILE DISASSEMBLY FACILITY	NC					
21.	BIF	BULK ITEM FACILITY	NA					
22.	MHE	MATERIAL HANDLING EQUIPMENT	NA					
23.	FIL	FILTER SYSTEM		459.3	2177	3261.9	7.10	0.9967
24.	MOR	MORTAR DEMIL MACHINE	NA					
25.	MIN	MINE DEMIL MACHINE	NA					
26.	PIP	PIPING		9.577	104412	27.121	2.83	≈1.0
27.	ELE	ELECTRICAL		509.916	1961	1031.496	2.02	0.9979
28.	MOD	SCALE MODEL	NC					
29.	PER	PERIMETER MONITORING	NC					
30.	CTV	CLOSED CIRCUIT TELEVISION		114.155	8760	228.310	2.0	0.9997
31.	COM	COMMUNICATIONS		365.296	2738	1095.888	3.0	0.9989
32.	DML	CHEMICAL LABORATORY	NC					
33.	DET	DETECTORS	NC					
34.	TDP	TECHNICAL DATA PACKAGE	NC					
35.	SCS	SITE CONTROL SYSTEM	NA					
36.	TNG	TRAINING	NC					
37.	RAM	REPAIR & MAINTENANCE	NC					
38.	SMP	SYSTEM MANAGEMENT AND PLANNING	NC					
39.	OES	OPERATIONAL ENGINEERING SUPPORT	NC					
40.	SIT	INITIAL TEST & SITE DEVELOPMENT	NC					
41.	SYS	SYSTEM INTEGRATION	NC					
		TOTAL MUNITION PROCESS		8086.8	123.7	58524.1	7.2	0.9450

NA - BB NOT APPLICABLE TO THIS MUNITION

NC - BB NOT CONSIDERED IN ANALYSIS PER PRIOR AGREEMENT

NEG - NEGLIGIBLE

6.0 PHASE III IDENTIFICATION OF PROBLEM AREAS AND RECOMMENDED CORRECTIVE ACTIONS

6.1 OBJECTIVES

The objectives of this study phase are:

- To identify potential maintainability and reliability problem areas
- To assess their significance with respect to CAMDS schedules and production rates
- To recommend corrective actions.

In compliance with these objectives the results of Phases I and II were reviewed to isolate and discuss maintainability and reliability problem areas. While most problems identified have schedule and production rates impacts, a few problem areas isolated were operational in nature with no direct schedule or production rate implications. These problem areas are non-the-less included in the following discussions.

6.2 PROBLEM AREAS AND RECOMMENDATIONS

6.2.1 Problem

The date scheduled for initial "hot" operations is currently less than seven months away. A review of the present state of systems readiness versus the actions necessary to accomplish system turn-on indicates an extremely tight schedule.

Significance: The schedule tightness will probably preclude extensive "hands-on" training of maintenance personnel and complete validation of corrective maintenance procedures. Considerable "downtimes" are projected due to unfamiliarity of repair crews with the equipment and repair procedures; systems initial availability may be degraded to unacceptable levels until "bugs" in the procedures can be eliminated and repair crew proficiency attained.

Recommended Action: Analyze the M55 Rocket line building blocks with special emphasis on isolating critical high failure rate items in hot (Level A) areas. At minimum, "hands-on" corrective maintenance training of these items should be accomplished. In addition, to the extent practical, validation of corrective maintenance procedures in hot areas should be accomplished prior to hot operations.

6.2.2 Problem

Target production rates can not be achieved for most munition types. In most cases, availabilities of the demil equipment are too low to meet target rates and improvement in equipment reliability and reduction of maintenance downtime are necessary. In other cases (105 mm cartridges), the basic design through-put capability of critical demil machines is grossly incompatible (i.e., too low) with the stated target production rates.

Significance: Equipment availabilities must be upgraded considerably if production targets are to be achieved. In the case of the 105 mm cartridges, production targets cannot be achieved with the present equipment.

Recommended Actions: Because of the relative complexity of the CAMDS demil machines and the advance stage of equipment design and procurement, upgrading of reliability and availability through equipment redesign options is very limited and very costly. As such, it is recommended that the CAMDS target production rates be reevaluated in light of the projected production rates for revision downwards if such is compatible with the overall objectives of the U. S. Army Chemical Munitions Disposal Program. If downward reduction of production target rates is unacceptable, reevaluation of the design approaches adopted should be made to identify production limiting processes/equipment and the equipment redesigned accordingly. Consideration should also be given to parallel demil lines of the same munition to meet production target rates.

6.2.3 Problem

Predicted availability of munition lines, predicated on maintenance factors assumed (somewhat arbitrarily) in the analysis, are lower than necessary to achieve production goals.

Significance: For lack of better data, maintenance factors were assumed to account for decreased maintenance personnel efficiencies stemming from protective clothing (which impedes mobility and reduces dexterity) and poor equipment maintenance access. These factors ranged from 1.5 to 4.0 and were somewhat arbitary in origin. Since the predicted availabilities are sensitive to these factors, use of invalid maintenance factors could produce very misleading maintenance parameters.

Recommended action: Perform tests, preferably using actual maintenance actions on the CAMDS equipment, with personnel performing in and out of suits (Level A) to evaluate and quantify these maintenance factors. As necessary, revise the maintainability analysis.

6.2.4 Problem

High failure rate items, typified by actuation cylinders, electromechanical valves, gear motors, and process sensors, are applied in many areas and used in a highly cyclical manner.

Significance: These items have great impact on system failure rates and therefore system reliability and availability.

Recommended action: Where practical, eliminate high failure rate items. Obtain failure rate data on specific equipment used. Standardize on the best designs based on use/test data.

6.2.5 Problem

Demil machine operations are designed as "bang-bang" type, with very little use of damper/shock absorbers.

Significance: This type of repetitive shock operations is inherently not conducive to maintenance of close tolerances between interfacing machine elements or close alignment of critical components. Alignment of position sensors, for example, can shift to malfunctioning positions which could stop production and/or damage equipment.

Recommended action: During equipment acceptance or shake down tests, inspect and monitor equipment alignment and positions for early detection and identification of shock sensitive alignments. Modify design as necessary to preclude shifting of machine elements or equipment under repetitive shock.

6.2.6 Problem

Indiscriminant "manual" operation of demil machines.

Significance: Manual operation of demil machines through control panels which bypass (override) the computer system can cause damage to equipment if wrong sequence or timing is used.

Recommended action: Restrict use of override control panels to predetermined, documented and approved procedures. Also limit personnel authorized to use override control panels.

6.2.7 Problem

Incomplete or obsolete engineering documentation of CAMDS equipment.

Significance: Substantial changes to the equipment are projected as a result of shake-down/acceptance testing. Without a comprehensive configuration control program, not all changes will be adequately documented. This could result in considerable difficulties in the isolation, diagnosis and correction of faults. In addition, adequate spares provisioning may be seriously impaired.

Recommended action: Implement and enforce a strict configuration control program. Update all engineering data as soon as possible and maintain current through provisions of the configuration control program.

6.2.8 Problem

RDM saw blade replacement is required roughly once per shift, and requires munition line shutdown and maintenance personnel in Level A suits.

Significance: Saw blade replacement can take a long time wearing Level A suits. This blade replacement time must be minimized to increase system availability.

Recommended action: Conduct blade replacement tests to develop procedures which minimizes the time required. Concurrently develop tooling to facilitate the operation.

6.2.9 Problem

Extreme low temperature operation.

Significance: Operability of the equipment may be reduced by low temperatures effects on exposed (weather) piping. While steam and electric tracings are employed on most exposed piping, the adequacy of the tracing capacity under extreme low ambient conditions and the operability of untraced lines is in doubt.

Recommended action: Review the design of all exposed piping (including tracing and insulation) for design adequacy. For lines not currently traced (e.g., pneumatic and hydraulic lines), determine low temperature operability. Either modify piping design to permit year round operation or establish low temperature limit for operation of the facility.

6.2.10 Problem

Handling procedures for fault analysis of failed items not established.

Significance: A systematic fault analysis and reporting procedures is necessary for effective isolation and elimination of design or equipment deficiencies. If these procedures are not available prior to initial operations of the facility, efficient isolation of design or equipment deficiencies may not be realized.

Recommended action: Establish procedures for handling and fault analysis of all failed items removed from the equipment. Establish special procedures for handling and evaluation of contaminated failed items.

6.2.11 Problem

Computer maintenance.

Significance: Computer corrective maintenance requires personnel with highly specialized training. These personnel are normally located in Salt Lake City which is too far removed from the CAMDS site for rapid responses necessary to support production targets.

Recommended action: Train sufficient personnel in the diagnosis and repair of the computer system to the replaceable module level.

6.2.12 Problem

Spare provisioning.

Significance: On-hand availability of spare parts is mandatory to minimize system down time.

Recommended action: Develop a spare parts inventory which will assure availability of the necessary repair parts to support the CAMDS systems. A record should be maintained of the use rate of critical items to generate appropriate replacement levels or schedules.

6.2.13 Problem

Potential toxicity of ETS particulate and charcoal filters.

Significance: Manual operations are employed for servicing of these filters. Although the sludge processed may be benign, no known attempt or provision is made to establish its non-toxicity prior to filter servicing. Off-normal operation or unusual events in the ECC could produce toxic sludge which may expose maintenance personnel and the ETS equipment (e.g., Vac-U-Max spent charcoal handling unit) to contamination.

Recommended action: Certification of the non-toxicity of the sludge generated in the ECC prior to processing by the ETS should be considered, or mandating all maintenance of the ETS be accomplished with Level A suits.

6.2.14 Problem

Upgrading building block and munition demilitarization line availabilities via design changes.

Significance: Study results indicate upgrading of availabilities will require considerable engineering analysis. For example, sheer redundancy does not appear to be a cost effective approach to increasing munition demil line availabilities; complete redundancy of the MPF, DFS and ADS increases the availability of the 105 mm, M360 cartridge with burster demilitarization line by only 1 1/2%.

Recommended Action: The munition line/building block designs should be evaluated to isolate single components or group of components, which by itself or together possess failure rates that represent a high percentage of the total munition line / building block failure rate. As available, test and operational experience should be employed to facilitate isolation of these failure prone items. Consideration should then be given to elimination of these items via redesign or substitution with more reliable hardware, or the incorporation of selected component redundancy as backup for these high failure rate items or groups thereof.

6.2.15 Problem

Identification of acceptance or shakedown test criteria for building blocks and munition demilitarization lines.

Significance: Without clearly identified operating requirements and performance standards, structuring and conduction of comprehensive acceptance and/or shakedown tests is impossible.

Recommended action: Prior to acceptance testing, a set of approved operating requirements and performance standards should be identified for all munition lines and their constituent building blocks. All test procedures should then be structured in accordance with approved test criteria based on those operating and performance requirements.

6.2.16 Problem

Absence of stalled motor detectors.

Significance: Stalled motors (e.g., RDM saws), if undetected, result in incomplete operations which could produce hazardous conditions or equipment damage.

Recommended action: Incorporate stalled motor detectors.

6.2.17 Problem

Inadequate operator space around computer in the control center (CON).

Significance: The working area in the control center around the computer and manual (computer override) control panels is extremely limited. During fault isolation episodes, the control center could be occupied by too many personnel (two operators, a shift supervisor, maintenance specialists and observers) for the space available, making efficient and effective operations difficult.

Recommended action: Remove the wall behind the operator's station to increase work area around the computer.

6.2.18 Problem

Lack of parts standardization. For example, in excess of 86 different hydraulic cylinders supplied by no less than 14 different manufacturers are specified. Many of the cylinders are similar with minor differences such as ½ inch stroke difference and cushioned vs. non-cushioned ends.

Significance: The diversity of spare parts stemming from non-standardization of parts results in a significant burden on maintenance resources. In addition, the large number of manufacturers complicates logistics, precludes spare parts standardization, and increases the need to familiarize the maintenance staff with the different manufacturer's equipment idiosyncrasi designs, styles and features.

Recommended Action: Because of schedule and cost constraints, and the advance stage of the equipment design and procurement, parts standardization is not practical for CAMDS. However, as part of any design modifications dictated by shakedown tests/or operating experience, parts standardization should be attempted (i.e., use parts already in the system to reduce the number of different parts). For future CAMDS designs, a strict parts standardization program should be promulgated and enforced early in the design process.

6.2.19 Problem

The CAMDS inventory control number (ICN) system employed results in a great number of identical items being specified under different ICN's.

Significance: Without the proper controls, a great number of identical items may be spared under different ICN's. For example, the Wilden Company Model M-8-5 diaphragm pumps (3 total) used in the BIF and PPD are each identified by different ICN's. Unless a cross referencing system is establis[hed] to note that these pumps are identical 3 pumps at approximately $1,500 each will be spared under their respective ICN. This duplicity of spare hardware can be a significant cost element and burden on maintenance resources.

Recommended Action: Establish and use an ICN cross referencing system to eliminate duplicity of hardware stored or revise the design drawings to ensure that all identical items are listed under common ICN's.

6.2.20 Problem

Ton container could be dropped during handling operations if sling fixture is not properly applied by operator.

Significance: Dropping of ton container is a personnel hazard and could cause damages to equipment and release significant quantities of agent.

Recommended Action: Modify sling fixture for positive lock on ton container.

6.2.21 Problem

Discrimination of emptied ton containers from filled or partially filled ton containers.

Significance: Visual determination of whether a ton container has been fully drained is not possible. Passing of filled or partially filled GB/VX ton containers to the MPF may occur.

Recommended Action: Incorporate in the BIF standing operating procedures, a requirement to positively mark all ton containers which have been drained.

6.2.22 Problem

Demil equipment electrical wiring not in conformance with the National Electric Code.

Significance: Electrical breakdown of switching circuits or wiring insulation can cause malfunction (e.g., unscheduled operation) of electric elements causing equipment damage during munition processing.

Recommended Action: Rewire control circuits in accordance with the National Electric Code.