SAB

REPORT OF THE AD HOC COMMITTEE ON ENHANCED NON-NUCLEAR MUNITION STORAGE

SCIENTIFIC ADVISORY BOARD
UNITED STATES AIR FORCE

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USAF SCIENTIFIC ADVISORY BOARD

AD HOC COMMITTEE ON

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INTRODUCTION AND SUMMARY

This report contains the findings of the SAB Ad Hoc Committee on Enhanced Non-Nuclear Munition Storage. The problem, as posed, concerns the lack of available real estate on current USAFE air bases to accommodate quantity-distance requirements resulting from the on-base storage of MK82/84 munitions in both aircraft shelters and storage igloos. The problem is compounded by the USAF objective to significantly increase on-base storage. Because of the high density of personnel and inhabited base facilities, there is inadequate separation (based on quantity-distance requirements) between potential explosive sites and inhabited base facilities. In order to maintain operational readiness and meet the training needs, the only recourse which the wing commander has for resolving this dilemma is to obtain waivers from the quantity-distance restrictions and manage the risks very carefully.

One solution for which there was high expectation was successful development of an insensitive high explosive (IHE) for general purpose bombs which would be equivalent in performance to the presently used explosive (tritonal). Unfortunately, this remedy appears to be a decade away unless some tradeoff with explosive performance is accepted. The committee examined numerous other remedies, many of which have applicability in the short term and can be directly applied to the current MK82/84 stockpile.

The committee concluded that there is no short-term panacea to this problem--however, there are a number of solutions available within the next 2-5 years which, if implemented in combination, could lead to favorable resolution of the current MK82/84 weapon stockpile storage problem.

STATEMENT OF THE PROBLEM

The storage of munitions in hardened aircraft shelters (HASs) is a significant problem in USAFE because of the shelters' close proximity to other essential (and inhabited) facilities. This problem is exacerbated by the Air Force requirement to reduce reliance on central storage areas by significantly increasing the on-base storage objective for non-nuclear munitions.

Current real estate restrictions require a large portion of base facilities to be operated under waivers because of inadequate quantity-distance (Q-D) separation from explosive storage sites. The MAJCOM has approval authority for Q-D waivers for existing facilities. However, new uses of existing facilities or new facilities requiring Q-D waivers must be approved by the Secretary of the Air Force (SECAF).

These Q-D restrictions impose constraints on base operations and training, and the sometimes arduous waiver process places an added strain on work force morale and quality of life.

STATEMENT OF THE PROBLEM

- OPERATIONAL REQUIREMENTS DICTATE LOADING AND STORAGE OF EXPLOSIVES IN HARDENED AIRCRAFT SHELTERS (HAS).
  - Inadequate Q-D separation of HAS from other base facilities requires waivers and/or reduces operational effectiveness.
- AIR BASE REAL ESTATE RESTRICTIONS SIGNIFICANTLY LIMIT ON-BASE WEAPON STORAGE BECAUSE OF INADEQUATE Q-D SEPARATION.
  - Relief from Q-D limitations by acquisition of additional air base real estate can be a long and tedious process.
- OPERATIONAL FLEXIBILITY, TRAINING EFFECTIVENESS, MORALE, AND QUALITY OF LIFE ON BASE ARE ADVERSELY AFFECTED BECAUSE OF THE DIFFICULTIES (REAL OR IMAGINED) ASSOCIATED WITH OBTAINING SECAF APPROVAL OF WAIVERS FOR NEW FACILITIES OR NEW UTILIZATION OF EXISTING FACILITIES WHERE Q-D SEPARATION IS INADEQUATE.

SAB AD HOC COMMITTEE

The committee was comprised of a representative cross-section of SAB Weapons Panel members and consulting scientists with expertise in design, development, and handling of munitions.

In addition to the members, the committee was ably assisted in the working meetings and on-site reviews by representatives of US Air Forces Europe (USAFE), the AF Inspection and Safety Center (AFISC), the AF Armament Division (AD), Air Force Logistics Command (AFLC), and USAFE field commanders.

SAB AD HOC COMMITTEE

SAB MEMBERS/ADVISORS	AFFILIATION
Mr Robert A. Norling (Chairman)	Bell Aerospace TEXTRON
Mr Robert G. Clem	Sandia National Laboratory
Dr John W. Taylor	Los Alamos National Laboratory
Dr Marvin R. Gustavson	Lawrence Livermore National Laboratory
Mr Edward James	Private Consultant
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Dr Robert V. Whitman	MIT
Dr Phil E. DePoy	Center for Naval Analyses
Dr M. Frederick Hawthorne	UCLA
Dr Robert W. Selden	Los Alamos National Laboratory
Mr Victor Lindner	US Army
Brig Gen John P. Schoeppner, Jr. (General Officer Participant)	USAF
Lt Col William L. Reynolds (SAB Executive Secretary)	USAF

MEETINGS HELD

The committee held several meetings between March and September, 1985, and received numerous briefings. In addition to briefings from the involved Air Force elements, briefings were received from the national laboratories, Army, Navy, and industry.

The briefings and facility reviews provided by the AF Inspection and Safety Center, USAFE Weapons Safety Division, and USAFE wing commanders were extremely significant and influential in the committee's findings.

MEETINGS HELD

Date	Location
19-20 MARCH 1985	AF INSPECTION & SAFETY CENTER, NORTON AFB, CA
6-7 MAY 1985	USAF SAB OFFICE, THE PENTAGON
13 AUGUST 1985	USAFE WEAPONS SAFETY DIVISION, RAMSTEIN AB GE
14 AUGUST 1985	52nd TACTICAL FIGHTER WING, SPANGDAHLEM AB GE
15 AUGUST 1985	50th TACTICAL FIGHTER WING, HAHN AB GE
15 AUGUST 1985	50th AMMUNITION SUPPLY SQDN, WENIGERATH GE
16 AUGUST 1985	USAFE WEAPONS SAFETY DIVISION, RAMSTEIN AB GE
25-26 SEPTEMBER 1985	USAF SAB OFFICE, THE PENTAGON

OBJECTIVES OF THE STUDY

All three objectives were addressed by the committee during the course of its reviews. The study output is contained in this report in the form of specific conclusions and recommendations for future action.

See study Task Statement at Appendix A.

OBJECTIVES OF THE STUDY

- REVIEW QUANTITY-DISTANCE REQUIREMENTS FOR CURRENT AND PROJECTED TAF STOCKPILE OF NON-NUCLEAR ORDNANCE IN THE EUROPEAN THEATER. REVIEW CURRENT AND PROJECTED STORAGE CAPABILITIES AND LOGISTICS DOCTRINE AS IT AFFECTS OPERATIONAL CAPABILITY.

- EVALUATE THE IMPACT OF STORAGE/HANDLING REGULATIONS ON OPERATIONAL CAPABILITY BOTH IN PEACETIME AND IN CONFLICT IN THE EUROPEAN ENVIRONMENT.

- RECOMMEND IMPROVEMENTS TO HANDLING AND STORAGE METHODS (INCLUDING MECHANICAL APPROACHES) WHICH WOULD IMPROVE MISSION CAPABILITY IN THE EUROPEAN ENVIRONMENT. CONSIDERATION SHOULD BE GIVEN TO DEVELOPMENT OF NEW EXPLOSIVES AND/OR POSSIBLE MODIFICATION OF EXPLOSIVE SAFETY REQUIREMENTS/REGULATIONS WHICH WOULD IMPROVE OPERATIONAL CAPABILITY WITHOUT COMPROMISE OF SAFETY. ESTIMATE THE IMPROVEMENTS IN MISSION CAPABILITY, MANPOWER SAVINGS, OR OTHER BENEFITS WHICH WOULD RESULT FROM SUCH MODIFICATIONS. OUTLINE A PLAN TO IMPLEMENT SUCH MODIFICATIONS.

HOW THE PROBLEM CAME TO BE

There appear to be four major reasons why the problems associated with on-base storage and handling of munitions has grown to its current magnitude. In general, these problems have resulted from utilization of base facilities to meet new requirements not envisioned at the time of construction and failure to fully anticipate and address these requirements early in the planning cycle. The consolidation of functions into a reduced number of bases has further exacerbated the problem. However, it is evident that effective effort is being put forth by both support and operating elements within the Air Force to understand and deal with the problem as it exists today. As a result, much progress has been made to accommodate the current situation and, fortunately, the impact on operational effectiveness has been minimized.

HOW THE PROBLEM CAME TO BE

- ORIGINAL CONCEPT FOR HARDENED AIRCRAFT SHELTERS (HASs) DID NOT ENVISION THEY WOULD BE USED AS EXPLOSIVE LOADING SITES.
- ON-BASE STORAGE REQUIREMENTS HAVE DRAMATICALLY INCREASED.
- PERSONNEL AND ON-BASE FACILITIES HAVE INCREASED IN NUMBER.
- ACQUIRING ADDITIONAL REAL ESTATE WAS REPORTED TO BE VERY DIFFICULT.

WHAT'S DRIVING?

Most of the explosive material which requires storage in both the hardened aircraft shelters and storage igloos is associated with the 500-pound MK82 and 2000-pound MK84 bombs. Approximately half of their total weight consists of hazard class 1.1 explosive.

Although the percentage of non-MK82/84 munitions will be increasing in future years, the problem will remain because of the very high (and still growing) quantity of general purpose bombs that will require on-base storage.

WHAT'S DRIVING?

- PEACETIME HANDLING AND STORAGE OF LARGE QUANTITIES OF MK82/84 BOMBS IN AIRCRAFT SHELTERS AND ON-BASE IGLOOS IS THE DRIVER.
  - Out-year weapon mix, containing a higher percentage of weapons with less explosive material per total unit weight and volume, will help some.
  - However, the basic problem remains.

PHILOSOPHY OF SAFE SEPARATION

The underlying philosophy of safe separation from explosive storage sites is based on time honored (and proven) quantity-distance (Q-D) criteria as they apply to a broad spectrum of applications. Risk levels inherent in the Q-D tables are established by DoD and any deviations require waivers approved by either the MAJCOM or SECAF.

The key assumption in application of Q-D criterion is the so-called maximum credible event (MCE). This is the net explosive weight (NEW) that is in sufficiently close physical proximity to participate in a single (and instantaneous) explosive event regardless of all other considerations. The underlying assumption is that other factors such as storage configuration, munitions orientation, or intervening barriers will not prevent the propagation of initiation through the entire volume. Consequently, if any accident occurs, there is unit probability of maximum energy release. Experience has demonstrated that this is a very conservative assumption.

PHILOSOPHY OF SAFE SEPARATION

- QUANTITY-DISTANCE (Q-D) CRITERIA ARE USED TO ESTABLISH THE REQUIREMENTS FOR THE PHYSICAL SEPARATION OF EXPLOSIVE STORAGE FACILITIES FROM EXPOSED SURROUNDING FACILITIES BASED ON AN ASSUMED OR PERMITTED LEVEL OF RISK.
  - Criteria are derived from empirical methods.
  - Levels of risk for each category of exposed site are established by DoD.
- DEVIATIONS FROM ESTABLISHED STANDARDS REQUIRE WAIVERS.
  - MAJCOM has waiver authority for existing facilities.
  - SECAF waiver is required for new construction or new utilizations of existing facilities.
- SEPARATION IS DETERMINED BY THE OCCURRENCE OF A MAXIMUM CREDIBLE EVENT (MCE).
  - MCE is the explosion consuming all of the explosive material considered available and capable of reacting in a single event.

Q-D RELATIONSHIPS

The safe separation distance (or clear zone) is defined by a simple formula. W is the net explosive weight (NEW) of the explosives involved in the maximum credible event (MCE). For blast damage from hazard class 1.1 explosives, the main thrust of the efforts to reduce D is aimed at finding ways to reduce the NEW associated with the MCE.

The K-factor defines risk levels and may be changed by (1) hardening the exposed site, (2) containment of the blast emanating from the explosive site, and (3) a reassessment of the risk levels associated with the Q-D tables.

Q-D RELATIONSHIPS

- THE DISTANCE (D) AT WHICH THE BLAST DAMAGE FROM AN EXPLOSIVE EVENT REACHES AN ACCEPTABLE LEVEL OF RISK FOR A SPECIFIED EXPOSED SITE IS DEFINED AS:

$$D = K(W)^{1/3}$$

WHERE W = NET WEIGHT OF EXPLOSIVES

K = FACTOR WHICH DEFINES THE LEVEL OF RISK PERMITTED AT THE EXPOSED SITE AND DEPENDS ON THE SPECIFIC CHARACTERISTICS OF THE EXPOSED SITE, THE EXPLOSIVE SITE, AND EXPLOSIVES CLASSIFICATION.

EXPLOSIVES CLASSIFICATIONS (CLASS 1)

By far, the major concern for storage of munitions is the blast effect of class/division 1.1 (mass detonating) explosives such as those contained in the tritonal filled MK82/84 bombs. Class/division 1.2 explosives also pose potential risks to base facilities, such as from structural fragments generated by an explosion in an aircraft shelter. Generally speaking, however, the clear zones for class/division 1.2 storage do not significantly limit the storage of munitions or encumber base operations in USAFE. Munitions which are class/division 1.3 or lower are categorized as "insensitive."

EXPLOSIVES CLASSIFICATIONS (CLASS 1)

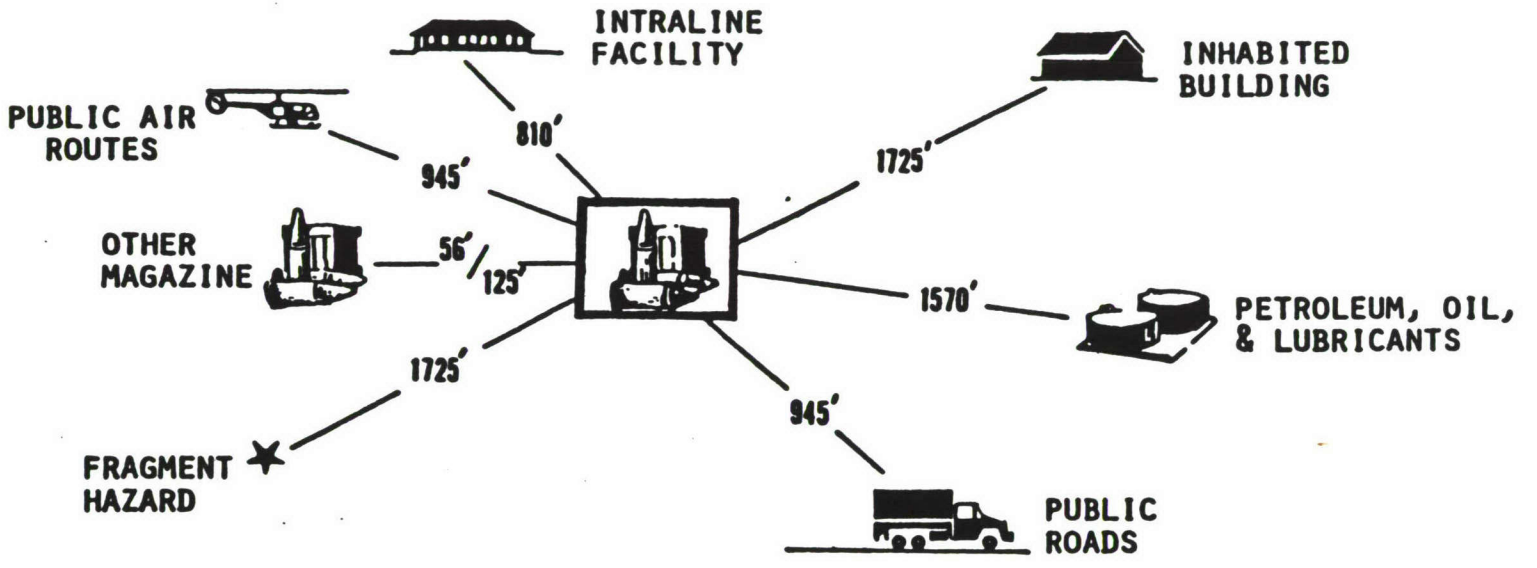
CLASS/DIVISION	DEFINITION	PRIMARY HAZARD
1.1	MASS DETONATING	BLAST
1.2	NON MASS DETONATING	FRAGMENT
1.3	MASS FIRE WITH POSSIBLE CONTAINER RUPTURE	CONFINED BLAST
1.4	MODERATE FIRE	

MUNITIONS STORAGE CONSIDERATIONS

Separation distances from a typical class/division 1.1 storage site (i.e., igloo) are shown for various categories of exposed sites. In general, USAFE air bases are not of sufficient size to meet these distance requirements.

MUNITIONS STORAGE CONSIDERATIONS

QUANTITY-DISTANCE CRITERIA



KEY CONSIDERATIONS AFFECTING Q-D CRITERIA:	TYPICAL STORAGE FACILITY:
• TYPE OF MUNITIONS STORAGE SITE • HAZARD CLASS OF MUNITION AND NEW • TYPE OF EXPOSED SITE • DISTANCE FROM MUNITIONS STORAGE • WAIVERS	• EARTH COVERED • NON-BARRICADED FRONT • 22,600 CUBIC FEET • 88,300# NEW RESTRICTION

THE CURRENT SITUATION IN USAFE

Because of limited real estate, USAFE air bases are heavily waivered. It is not uncommon to have 60-70% of the base within explosive clear zones.

In order to maintain operational effectiveness and readiness, reasonable risks are accepted. The increasing on-base storage objectives will further exacerbate the wing commander's problems and constraints. Accordingly, the risk management work load will continue to grow.

THE CURRENT SITUATION IN USAFE

- BASES ARE OPERATING WITH THE MAJORITY OF REAL ESTATE WITHIN EXPLOSIVES CLEAR ZONES.
  - High density of personnel and facilities on base
  - Increasing requirements for on-base munition storage
  - Limited real estate
  - Operational compromises being made
- USAFE POLICY:
  - Accept reasonable risks consistent with operational need.
  - Give the risk high visibility.
  - Manage the risk.

ENHANCED STORAGE OPTIONS AVAILABLE

There are a number of enhanced storage options available. They vary widely as to current development maturity, potential availability, risk of achieving the desired result, and their impact on the logistical cycle. These options were reviewed by the committee in varying degrees of detail. Conclusions are drawn as to future potential of the identified option and specific recommendations are made for future Air Force actions.

ENHANCED STORAGE OPTIONS AVAILABLE

- WAIVERS/RISK MANAGEMENT
- MODIFICATION OF Q-D CRITERIA
- COMPARTMENTALIZATION BY INERT PARTS/LOWER CLASS MUNITIONS
- COMPARTMENTALIZATION BY BLAST SHIELDS
- MECHANICAL DIVERTERS
- IN-GROUND VAULTS
- LAND ACQUISITION
- DESENSITIZED HIGH EXPLOSIVES
- FACILITY HARDENING
- UNDERGROUND IGLOO
- INSENSITIVE HIGH EXPLOSIVES

CONCLUSION #1

The committee was somewhat surprised at the percentage of base facilities operating within the explosives clear zone. This is particularly troublesome since requirements for on-base storage continue to increase. Because of the excellent job being done by the wing commanders and their staffs, this problem does not appear to be impacting peacetime operational effectiveness and readiness. However, morale and quality of life on base are impacted by the restricted use of facilities, coupled with the uncertainties and delays associated with the waiver process. The inability to store an adequate supply of munitions on base can significantly compromise timely transition to wartime operations.

CONCLUSION #1

- IN THE CURRENT PEACETIME ENVIRONMENT, LARGE PORTIONS OF OUR AIR BASES ARE OPERATING UNDER Q-D WAIVERS.
  - Has minimum impact on peacetime operations and training
  - Can have significant adverse effect on quality of life on base
  - Can significantly compromise ability to effectively transition to wartime operations

CONCLUSION #2

One of the most important conclusions evolves from the realization that an all-encompassing solution does not appear to exist. In the committee's opinion, there are no quick fixes or easily applied technology solutions. However, there do appear to be a number of reasonably promising high and low technology approaches which should be pursued. They vary as to potential availability, risk, logistical impact, etc., and, therefore, it is difficult to accurately assess their operational effectiveness without further analysis and product development. Among the identified approaches are a few which could have benefits in the relatively short term.

CONCLUSION #2

- THERE IS NO FORESEEABLE PANACEA:
  - For achieving Air Force on-base storage objectives.
  - For significantly alleviating the current waiver situation.
- THERE ARE A NUMBER OF POTENTIALLY FRUITFUL AVENUES OF APPROACH WHICH, IF AGGRESSIVELY PURSUED IN PARALLEL AND IMPLEMENTED IN COMBINATION, WILL SIGNIFICANTLY ENHANCE ON-BASE MUNITION STORAGE IN USAFE.

RECOMMENDATIONS (#2)

Since no single remedy or approach appears to provide the total answer, it follows that all promising approaches should be pursued at least to a significant achievement milestone. In addition, systems effectiveness over the complete logistical cycle should be assessed before significant funding is committed.

A reasonably detailed development and deployment road map with decision milestones should be constructed for all promising approaches. The resulting program elements should be monitored and judged against a common set of system requirements and evaluation criteria.

RECOMMENDATIONS (#2)

1. FUND ALL PROMISING AVENUES OF APPROACH AND, IN PARALLEL, EVALUATE THEIR TOTAL SYSTEM IMPLICATIONS.

2. DEVELOP AN INTEGRATED ROAD MAP FOR ENHANCING THE ON-BASE STORAGE OF CONVENTIONAL MUNITIONS.

CONCLUSION #3

The burden of munition storage and its related problems inevitably falls on the shoulders of the wing commander and his staff. The committee believes they are taking a reasonable approach to managing risks under difficult conditions without compromising operational effectiveness. Safety personnel from HQ USAFE and AFISC are providing essential support and are also laboring under a heavy workload.

CONCLUSION #3

- OPERATIONAL COMMANDERS ARE DOING A GOOD JOB OF MANAGING THE RISKS ASSOCIATED WITH ON-BASE STORAGE OF MUNITIONS UNDER DIFFICULT CONDITIONS.
  - Enlightened understanding exists of tradeoffs between safety of personnel and operational needs.
  - AF safety personnel are doing an excellent job (with limited resources) of supporting wing commanders in managing risks, reducing restrictions, and justifying waivers.

RECOMMENDATIONS (#3)

The committee agrees with the approach being taken by field units and believes the quality of effort is very high. We can offer very little in the way of specific recommendations other than to strongly urge that lessons learned are shared, that the current high standards are maintained, and that safety personnel have adequate resources to support the wing commanders' needs.

RECOMMENDATIONS (#3)

1. ASSURE THAT LESSONS LEARNED ARE SHARED BETWEEN THE WING COMMANDERS.
2. MAINTAIN HIGH LEVEL OF SENSITIVITY AND PRIORITY FOR AIR BASE SAFETY.
3. ASSURE THAT ADEQUATE RESOURCES ARE AVAILABLE TO SUPPORT AIR BASE SAFETY NEEDS.

CONCLUSION #4

The probability of discovering a relatively cheap melt-castible insensitive high explosive (IHE) in the short to intermediate term is extremely low. Currently, the only fully developed IHE material is TATB, which was developed for nuclear weapon applications. It appears to be prohibitively expensive for non-nuclear applications and is not melt-castible. Melt-castibility is not only important for easy implementation of the manufacturing process, but is a property that is required in IHE material in order for it to be retrofitted into the existing large inventory of MK82/84 weapons.

The outlook for near term success in developing IHE is dimmed by lack of a fundamental understanding of the factors which influence initiation sensitivity of condensed phase explosives. Beyond the fundamental developments would be the full development engineering, manufacturing proveout, and performance validation process.

The current IHE program at Armament Division appears to be properly aimed but is somewhat below critical mass due to resource limitations. Recent reviews show encouraging results with an explosive formulation of less energy than tritonal.

CONCLUSION #4

- SUCCESSFUL ENGINEERING DEVELOPMENT, MANUFACTURING PROCESS VALIDATION, AND OPERATIONAL VERIFICATION OF A TECHNICALLY ACCEPTABLE AND AFFORDABLE IHE FOR USE IN AF MUNITIONS WILL TAKE A VERY LONG TIME.
  - IHE will not be available to alleviate current munition storage problems.
  - IHE solutions embrace a broad spectrum of R&D and operational issues, including hazard classification testing, explosive performance compatibility with MK82/84 hardware, storability and aging, manufacturability, cost, etc.
  - IHE program at Armament Division appears to be addressing proper issues within resource limitations.

RECOMMENDATIONS (#4)

The significant benefits of IHE, if successfully developed, justify a continuing level-funded 6.1 and 6.2 program. The committee believes that annual funding in the order of $10M is appropriate and necessary to achieve the desired objectives. The committee is also of the opinion that future efforts should be focused on known explosive systems and their variants. Since known materials such as TATB and NQ cannot be melt-cast, fundamental changes in bomb manufacturing technology may be essential for successful development of an IHE. Both the Army and Navy have IHE programs underway. It is noteworthy that the Navy has established a goal to successfully develop insensitive munitions within a decade. The Air Force should closely coordinate its program with the other Services.

RECOMMENDATIONS (#4)

1. THE IHE PROGRAM SHOULD BE GIVEN HIGH R&D PRIORITY BECAUSE OF ITS POTENTIALLY HIGH PAYOFF. ESTABLISH A LEVEL-FUNDED PROGRAM (6.1 & 6.2).

2. ESTABLISH GROUND RULES FOR R&D PROGRAM (E.G. COST, COMPATIBILITY WITH EXISTING HARDWARE, PRODUCTION RATES, ETC.).

3. STAY WITH EXISTING KNOWN MOLECULAR SYSTEMS.

4. MAINTAIN CLOSE COORDINATION WITH NAVY AND ARMY IHE PROGRAMS.

CONCLUSION #5

Notwithstanding the unfavorable outlook for IHE, it may be possible to achieve a desensitized high explosive (DHE) using tritonal or other existing bomb fills by combining the explosive with wax or synthetic polymers. This, in appropriate storage configurations, could reduce the MCE in storage shelters. For example, if an explosive could be found which met all IHE tests but slow cookoff, the associated MCE would be significantly reduced in a storage shelter which contained no flammable materials. In general, desensitization appears to be synergistic with other approaches to reduce the MCE.

If successful, this approach would retain the melt-castibility property of tritonal and would allow application to our current large stockpile of bombs.

CONCLUSION #5

- DEVELOPMENT OF DESENSITIZED (AS OPPOSED TO INSENSITIVE) HIGH EXPLOSIVES WHICH WOULD MINIMIZE, BUT NOT NECESSARILY ELIMINATE, THE POSSIBILITY OF MASS DETONATION SHOULD BE GIVEN SERIOUS CONSIDERATION.
  - May have significant benefits and earlier availability than IHE
  - May significantly reduce maximum credible event in storage shelters when combined with appropriate hazard evaluations
  - Is synergistic with other approaches (e.g., diverters)

RECOMMENDATIONS (#5)

The objective of this effort should be to seek a desensitized explosive in the near to intermediate term through relatively minor modifications to existing melt-castible bomb fills. The effect of such modifications (additives) on explosive performance and its compatibility with existing MK82/84 hardware (e.g., fuzes) must be thoroughly evaluated.

RECOMMENDATIONS (#5)

1. INVESTIGATE MODIFICATIONS TO EXISTING MELT-CASTIBLE EXPLOSIVES.
2. CONTINUE TO INVESTIGATE WAX OR SYNTHETIC POLYMER ADDITIVES TO TRITONAL.
3. EVALUATE EXPLOSIVE PERFORMANCE.

CONCLUSION #6

The use of inert parts (e.g., fins, containers, etc.) and/or lower classification explosives (e.g., 20mm ammo, CBUs, etc.) as barriers (or blast shields) between pallets of MK82/84 bombs has been under investigation for some time by the AFISC. This technique has excellent promise based on the test results achieved to date. Since favorable results from full scale explosive testing are immediately applicable, this approach has the advantage of benefiting the current inventory in the short term. The committee believes that this approach continues to have excellent payoff. Recent explosive tests have resulted in significant improvements in the storage of MK82/84 bombs in the U.K. with savings of the equivalent of approximately 250 shelters.

The ongoing test program is essential to achieving these benefits. Surprisingly, the Air Force does not have a funded test program, despite the numerous benefits which have resulted from it. AFISC obtains support from AFLC (Ogden ALC) and munitions assets from HQ USAF. Lack of a funded program appears to be inconsistent with the high priority that the Air Force has attached to weapon storage.

CONCLUSION #6

- SPECIAL STORAGE ORIENTATIONS OR SELECTIVELY MIXING CLASS 1.1 MUNITIONS WITH INERT PARTS AND/OR LOWER CLASSIFICATION EXPLOSIVES IN THE STORAGE IGLOOS (TO CREATE STRUCTURAL BARRIERS BETWEEN THE EXPLOSIVE ELEMENTS) CAN HAVE HIGH PAYOFF IN THE SHORT TERM.
    - In future years, there will be a larger percentage of high volume/weight weapons (e.g., missiles and cluster munitions) resulting in a greater quantity of inert and lower classification explosives to be stored per MK82/84 bomb unit.
- EXPERIMENTAL VERIFICATIONS OF THE EFFECTIVENESS OF SPECIFIC STORAGE CONFIGURATIONS ARE KEY TO INCREASING THE STORAGE CAPACITY OF MUNITIONS ON AIR BASES.
    - Recent test programs have had excellent payoff in reducing Q-D restrictions. on air bases.
    - Lack of a funded program is inconsistent with stated USAF objectives
    - Potentially high payoff in the short term.

RECOMMENDATIONS (#6)

On the basis of the significant results achieved to date and the prospects for significant future benefits, the committee strongly recommends that the Air Force establish a funded test program under direction of AFISC. The funded program should be given appropriate high priority to investigate additional munition storage configurations.

RECOMMENDATIONS (#6)

1. PURSUE AN AGGRESSIVE TESTING PROGRAM UNDER THE DIRECTION OF THE AIR FORCE INSPECTION AND SAFETY CENTER.

2. ESTABLISH A FUNDED PROGRAM. GIVE IT HIGH PRIORITY.

CONCLUSION #7

Fractionalizing the stored explosives by use of tailored blast shields is a low technology solution which appears to have high payoff. It has the advantage of being effective almost immediately and can be applied to the current inventory. For example, the Army already has a technical data package for rolling concrete barriers which are used to segregate ammunition trucks. The result of the shield is that the MCE is limited to the NEW of a single truck. Blast shields have also been used as protective devices in munition factories and in testing explosive materials where various materials and systems architectures have been employed.

CONCLUSION #7

- USE OF BLAST SHIELDS, SIMILAR TO THOSE USED IN MANUFACTURE OF MUNITIONS, TO COMPARTMENTALIZE PALLETS OR GROUPS OF PALLETS IN STORAGE SHEDS, IGLOOS, AND HARDENED AIRCRAFT SHELTERS HAS HIGH POTENTIAL FOR REDUCING MCE OF STORAGE STRUCTURES.
  - Existing technology can be immediately applied to enhance storage of current inventory.

RECOMMENDATIONS (#7)

High priority should be given to evaluating effectiveness of blast shields using existing material systems and design configurations. The committee recommends immediate incorporation into the AFISC testing program. Careful thought must be given to the logistic aspects such as precisely how the barriers will be arrayed in the storage shelters to facilitate ease of access to the munitions. There will undoubtedly be a tradeoff between the degree of fractionalization (i.e., reduction of MCE) and associated inefficiencies in storage area utilization and accessibility to the munitions. The resulting Q-D benefits and the costs and risks of these benefits must be quantitatively assessed by analysis.

RECOMMENDATIONS (#7)

1. INVESTIGATE EFFECTIVENESS OF BLAST SHIELDS UTILIZING EXISTING MATERIALS. INCORPORATE INTO TESTING PROGRAM.

2. ANALYZE THEIR UTILIZATION IN STORAGE CONFIGURATIONS (IGLOOS AND HAS) AND DETERMINE Q-D BENEFITS.

CONCLUSION #8

Use of diverters or separators is the ultimate step in fractionalization since its objective is to reduce the MCE (or NEW) to that of a single MK82/84 weapon explosion. Although the instrumented tests performed at Air Force Armament Division over the past year have yielded promising results and established concept feasibility, an operationally suitable configuration and material has not been derived nor has a product specification been defined. Diverters will impose a storage volume penalty and adversely impact current handling, storage, and weapon buildup procedures. An extensive program will be required to validate and qualify the product over its complete operational and logistic cycle.

CONCLUSION #8

- USE OF MECHANICAL DIVERTERS OR SEPARATORS TO MITIGATE THE CRITICAL ANGLES AND FRAGMENT VELOCITIES BETWEEN ADJACENT BOMBS (THEREBY ELIMINATING DETONATION OF ADJACENT BOMBS) APPEARS TO HAVE HIGH POTENTIAL WITH APPLICABILITY IN THE SHORT TO INTERMEDIATE TERM.
  - There will be a pallet volume penalty, depending on the specific device selected.
  - The logistical penalties and cost implications of this approach over the entire transportation, storage, handling and operational process have not been evaluated.
- THE KEY TO DEVELOPING A VIABLE SOLUTION OF THIS TYPE IS ACQUISITION OF AN ADEQUATE TEST DATA BASE.

RECOMMENDATIONS (#8)

Development, production, and incorporation of diverters into the operational inventory will require an intense and highly focused RDT&E program. Although the acquisition of a broad R&D data base is essential, it will be necessary to focus the product development effort on materials and configurations which satisfy product specifications in order to meet a deployment time line with high confidence. A comprehensive logistic study also must be conducted to provide a rational basis for establishing the product specifications.

Specific concept validation milestones should be established and achieved before committing to FSD. The physics of the mitigation process should be thoroughly in hand and backed by an adequate test data base. Operationally suitable materials should be identified and characterized. The logistic procedures and requirements should be established and validated by operational elements.

RECOMMENDATIONS (#8)

1. IMPLEMENT HEAVILY INSTRUMENTED TEST PROGRAM TO DETERMINE PROPAGATION MECHANISMS AND OPTIMUM DIVERTER CHARACTERISTICS (I.E., MATERIALS, SHAPE, DIMENSIONS, ETC.).

2. CONDUCT (IN PARALLEL WITH TEST PROGRAM) A COMPREHENSIVE LOGISTIC STUDY DETAILING THE COSTS, BENEFITS, PENALTIES, AND RISKS ASSOCIATED WITH DIVERTER UTILIZATION.

3. DEVELOP A PRODUCT SPECIFICATION.

4. SUCCESSFULLY COMPLETE ADVANCED DEVELOPMENT OR SUFFICIENT RISK REDUCTION BEFORE PROCEEDING TO FSD.

CONCLUSION #9

Storage of munitions in the hardened aircraft shelters poses a particularly difficult problem because of the shelters' close proximity to one another and to other base facilities. In addition to (and concurrent with) the up-loading and down-loading of live munitions, combat quick-turns are sometimes performed in the HAS. Previous explosive testing by AFISC has determined that proper orientation of the MK82 bombs (relative to one another) within the shelter permits simultaneous storage of up to 12 bombs (depending on shelter size) without increasing the MCE above that associated with the detonation of a single MK82. Notwithstanding this, for multi-mission applications, it becomes difficult, if not impossible, to store even one or two loadouts for all missions without violating Q-D criteria.

Real estate is available adjacent to the shelters for in-ground vaults in which weapons can be stored. This approach would relieve the need to store munitions in the shelter while retaining the advantage of close proximity between the aircraft and weapons. The committee believes that this approach has high potential because of the low technology required for implementation and its applicability to the current inventory.

Also presented to the committee were other concepts which represent major philosophic changes in design approach to both aircraft storage structures (e.g., the Norwegian HAS design) and munition storage structures (i.e., igloos). Their availability is long term and applies only to the construction of new facilities.

CONCLUSION #9

- CONCEPTS SUCH AS UNDERGROUND STORAGE VAULTS AND MINI-IGLOOS ARRAYED IN CLOSE PROXIMITY TO THE HARDENED AIRCRAFT SHELTER WITH CAPABILITY TO STORE ONE OR TWO MISSION LOADS APPEAR TO HAVE MERIT.
  - Handling and storage risks, costs, and benefits have not been adequately studied.
  - Benefits are realizable in the intermediate term.
- OTHER CONCEPTS MERIT INVESTIGATION:
  - Deep underground storage structures
  - Improved HAS designs

RECOMMENDATIONS (#9)

The committee recommends that new design concepts be analyzed further to establish their utility. In particular, the use of in-ground vaults adjacent to the HAS for safe storage of easily accessed munitions should be given thorough investigation since it represents a potentially viable near-term solution. Possible risk areas are environmental intrusion protection of the vaults and blast confinement in the event of a detonation.

RECOMMENDATIONS (#9)

1. PERFORM FEASIBILITY AND ENGINEERING TRADE STUDIES OF STORAGE VAULTS (IN-GROUND, CLOSE TO SHELTERS) THROUGH CONCEPT DESIGN.

2. EVALUATE COST, RISK, AND LOGISTICAL IMPACT.

3. INVESTIGATE AIRCRAFT SHELTER CONCEPTS DESIGNED TO VENT BLAST AND MINIMIZE FRAGMENTS.

4. DETERMINE IF SUCH CONCEPTS WARRANT FURTHER EFFORT.

5. ANALYZE THE FEASIBILITY OF UNDERGROUND STORAGE STRUCTURES AND THEIR APPLICABILITY/ AVAILABILITY TO WEAPON STORAGE IN USAFE.

CONCLUSION #10

The committee saw no evidence of hardening inhabited facilities as a means of reducing the Q-D separation requirements. Current solution criteria are based on glass damage from shattered windows. However, it is possible to harden facilities to window blast damage if desired. Usually this would involve modifications to only one or two sides of the building which are exposed to the explosive site.

CONCLUSION #10

- SELECTIVE HARDENING OF AT-RISK FACILITIES COULD RESULT IN SIGNIFICANT REDUCTIONS IN SEPARATION DISTANCE.
  - Change of overpressure limit from 1.2 PSI (window damage) to other limits of human tolerance could significantly reduce required separation distance.

RECOMMENDATIONS (#10)

Hardening of facilities to pre-established levels appears to be of reasonably low technical risk. However, other factors come into play which are probably more important and somewhat more nebulous, such as work force acceptance. Since hardening has not received much attention, the committee recommends that this approach be investigated sufficiently to determine potential Q-D benefits and associated costs.

RECOMMENDATIONS (#10)

1. DETERMINE COST, BENEFITS, AND OTHER FACTORS (INCLUDING PERSONNEL ACCEPTABILITY, QUALITY OF LIFE, ETC.) ASSOCIATED WITH HARDENING MODIFICATIONS TO EXISTING (OR NEW) INHABITED STRUCTURES.

2. INVESTIGATE LEVELS FROM 1.2 PSI OVERPRESSURE TO LIMITS OF HUMAN OR STRUCTURAL TOLERANCE.

CONCLUSION #11

Although land acquisition remains difficult and tedious, it continues to provide significant benefits when achieved. This is evidenced by the effective use which wing commanders have made of added real estate to relieve Q-D restrictions and improve living conditions on base. The committee was told that it normally takes five years to complete a negotiation. Compared to some of the high technology solutions which are being considered, it appears that land acquisition continues to be a competitive approach. In certain situations, additional real estate may be the only answer. The committee feels strongly that this approach should be given high priority in USAFE Headquarters and the Air Staff.

CONCLUSION #11

- LAND ACQUISITION IS REPORTED TO BE VERY DIFFICULT AND IS A SERIOUS CONSTRAINT. HOWEVER, ACQUIRING ADDITIONAL LAND MAY NOT TAKE AS LONG OR BE AS EXPENSIVE AS OTHER SOLUTIONS (E.G., IHE).
  - May be a comparatively cost-effective solution.
  - Small additions can have large impacts.

RECOMMENDATIONS (#11)

The brunt of the effort to acquire additional land needed by the air bases is borne by the individual wing commanders and their staffs. Notwithstanding the increase in their already heavy work load, the wing commander and his staff are not necessarily skilled in such matters nor are they able to bring significant leverage to the negotiation process. Assistance from USAFE Headquarters or other higher level government elements would improve the ability to negotiate for added land by introducing land swapping or other quid pro quo.

The committee recommends development of a land acquisition master plan which identifies potentially available land and details an acquisition program for each base. Concurrently, consideration should be given to what could be used in quid pro quo trade.

RECOMMENDATIONS (#11)

1. DETERMINE WHERE ADDITIONAL LAND IS DESIRED (OR COULD BE SURRENDERED) AND IMPLEMENT A LONG-RANGE LAND ACQUISITION PROGRAM.

2. PROVIDE INCREASED ASSISTANCE TO WING COMMANDERS IN PROGRAM IMPLEMENTATION.

CONCLUSION #12

The loaded aircraft in the HAS represents a special case of munition storage. Although it is a transitory situation, the scenario is most complex (munition up-loading, refueling, operations in chemical protection gear, etc.) with the hazard level relatively high and difficult to assess. The relative orientation of the bombs on the MERs/TERs is such that all weapons will participate in a mass detonation. Generally speaking, except for high wing configurations, the weapons are all exposed to each other and the resulting MCE would be many times greater than for the unloaded aircraft in the HAS storage configuration.

Although this special situation has not been specifically addressed by any candidate solution, some of the solutions under consideration may apply.

CONCLUSION #12

- SPECIFIC SOLUTIONS HAVE NOT BEEN IDENTIFIED FOR MITIGATING Q-D REQUIREMENTS FOR LOADED AIRCRAFT IN HARDENED SHELTERS.
  - Loaded MERs and TERs lead to storage situations which require waivers.
  - Diverters, blast curtains, DHE, and IHE may be applicable.

RECOMMENDATIONS (#12)

The committee recommends that an in-house Air Force study be initiated to define and examine the HAS scenario in depth. Risk factors should be given high priority. Develop preferred approaches using the candidate solutions applicable to this scenario as a point of departure. Formulate an approach and define a validation and test program if appropriate.

RECOMMENDATIONS (#12)

1. INITIATE AN IN-HOUSE STUDY TO ADDRESS THE AIRCRAFT SHELTER STORAGE SITUATION. DETERMINE AND EVALUATE METHODS FOR ELIMINATING MULTIPLE DETONATIONS ON LOADED AIRCRAFT.

2. EVALUATE OPERATIONAL AND RISK FACTORS.

3. VERIFY BY TEST.

CONCLUSION #13

The Q-D tables are based largely on empirical data which in general lead to over-estimates of separation distance for the assumed levels of risk. Although the committee believes that the assumed risk levels reflected in the tables should not be increased, the over-estimates of separation distances associated with those risk levels should be eliminated if possible.

The Q-D tables should be tailored to the storage of USAF munitions. More relevant tables would help to relieve the wing commanders' risk management burdens.

CONCLUSION #13

- THE Q-D TABLES ARE BASED ON A WORST CASE SCENARIO AND ASSUME THAT ALL MUNITIONS WILL DETONATE INSTANTANEOUSLY.
  - This results in application of maximum Q-D.
  - There is increasing experimental and analytical evidence that occurrence of the MCE is unlikely in storage conditions.
  - There are storage techniques (including munition positioning and compartmentalization) which can significantly reduce the magnitude of the MCE.
- APPLICATION OF Q-D CRITERIA SHOULD BE DEVELOPED FURTHER IN TERMS OF ITS RELEVANCE TO STORAGE OF USAF MUNITIONS.
  - MCE appears to be overstated in many operational situations.
  - Likelihood of occurrence of an event is not weighted in application of the tables.
  - Consequence of an event (given that it occurs) in terms of expected injury to personnel is not considered.

RECOMMENDATIONS (#13)

Tailoring the Q-D tables to the specific situation will significantly enhance storage of USAF munitions. The testing program under the direction of AFISC supports such tailoring and has resulted in significant benefits to the storage problem. It should be accelerated.

The objective of the program recommended here and supported by many previous recommendations is to validate, by testing and analysis, the extent to which the maximum credible event can be defined on a basis other than physical proximity of explosives. It is clear that such redefinitions will be situation and location dependent. Although Air Force safety rules and procedures may become more detailed as a consequence, they will become more supportive of operational requirements.

Provide maximum support to the wing commanders' risk management efforts. A detailed hazard analysis considering physical characteristics and operational utilization of the explosive and exposed sites should be conducted for situations in which the Q-D requirements are overstated by the tables.

RECOMMENDATIONS (#13)

1. ACCELERATE CURRENT TESTING PROGRAM TO BETTER DEFINE MCE.

2. PERFORM RISK ANALYSES TO IMPROVE UNDERSTANDING OF LIKELIHOOD OF OCCURRENCE AND ITS CONSEQUENCES. CONTINUE TO SUPPORT THE WING COMMANDERS' EFFORTS TO ASSESS AND MANAGE RISKS.

3. APPLY MODERN ANALYTICAL AND COMPUTATIONAL TOOLS TO BETTER UNDERSTAND THE PHYSICAL PROCESSES AND SCALING LAWS ASSOCIATED WITH GENERATION AND APPLICATION OF THE Q-D TABLES.

CONCLUSION #14

The committee believes that a lack of early recognition of the storage and handling requirements in the weapon development process has exacerbated the weapon storage problem. Early consideration should be given to handling and transportation, hazard level, and storage requirements.

CONCLUSION #14

- LONG-TERM MUNITION STORAGE AND HANDLING REQUIREMENTS ARE GENERALLY NOT GIVEN ADEQUATE CONSIDERATION IN THE DEVELOPMENT AND ACQUISITION PROCESS.
  - Neither the program management directive nor the Munitions Acquisition Plan assure a comprehensive basing/facility requirements study.
  - Late assessment of hazard levels complicates determination of storage requirements for new munitions.
  - There is very little forecasting of shipping and handling technology requirements.

RECOMMENDATIONS (#14)

The Program Management Directive and other advanced planning tools should establish requirements and provide funds for development of storage and handling technology concurrently with weapon deployment.

A detailed hazard evaluation performed during the weapon development phase would bring early focus on potential Q-D related storage and handling problems. Such an evaluation should lead to the most efficient means for weapon handling and storage. Although this recommendation does not necessarily address remedies for current problems, it is essential that future developments not further exacerbate the current storage problems.

RECOMMENDATIONS (#14)

1. THE PROGRAM MANAGEMENT DIRECTIVE SHOULD ESTABLISH THE NEED FOR FUNDING AND PROCEDURES FOR HAZARD ASSESSMENT AS WELL AS PROVISIONS FOR DEVELOPMENT OF STORAGE AND HANDLING TECHNOLOGY.

2. THE AIR FORCE SHOULD ESTABLISH A REQUIREMENT FOR A HAZARD EVALUATION IN THE BASING/FACILITY STUDY AND MUNITIONS ACQUISITION PLAN.

CONCLUSION #15

The weapons safety organizations in USAFE and at AFISC are critical to resolving the weapon storage problems in USAFE. Both organizations are understaffed in terms of the work to be accomplished. Although the necessary and urgent coordination required to support the operating elements is being accomplished, a very large backlog of work exists in both organizations.

CONCLUSION #15

- USAF WEAPONS SAFETY ORGANIZATIONS ARE UNDERSTAFFED IN TERMS OF PROBLEM CRITICALITY.
  - They have limited capability for generating new storage criteria.
  - There are excessive delays in processing waivers and exemptions due to heavy backlog.
  - Requirements to evaluate benefits of test programs will compound the problem.

RECOMMENDATIONS (#15)

The manning levels of the participating safety organizations should be reviewed. The organizations should be staffed to eliminate the work backlog within a reasonable period of time. Consideration should also be given to employing an industrial contractor.

In the long run, the Air Force may find it in their best interest to consider "safety" as an accepted career specialty with promotional opportunity. This approach would allow assignment of experienced safety officers, fully capable of dealing with the panoply of on-base weapons and other safety issues, to operational wings.

RECOMMENDATIONS (#15)

1. REVIEW MANNING STANDARDS AND STAFF NEEDS OF PARTICIPATING SAFETY ORGANIZATIONS, E.G., AFISC AND USAFE WEAPONS SAFETY DIVISION.

2. SAFETY OFFICER "CAREER BROADENING" PHILOSOPHY SHOULD BE RE-EXAMINED. CONSIDER SAFETY AS A CAREER SPECIALTY WITH PROMOTIONAL OPPORTUNITY.

3. CONSIDER USE OF INDUSTRIAL CONTRACTORS.

CONCLUSION #16

There are many players involved in the safe storage of munitions and air base safety. By their very nature, the mission organizations which have legitimate responsibilities are highly fragmented. To make this point, a partial listing of responsible organizations is shown. The wide variety of involved organizations leads to complex and difficult management problems.

CONCLUSION #16

- OVERALL MUNITIONS STORAGE PROGRAMS AND ASSOCIATED OPERATIONS, AS THEY RELATE TO AIR BASE SAFETY, ARE HIGHLY FRACTIONATED. FOR EXAMPLE:
  - AIR FORCE ARMAMENT DIVISION: Research, development, and acquisition program implementation (e.g., IHE, diverters, etc.)
  - AIR FORCE INSPECTION AND SAFETY CENTER: Safety, verification, testing, waiver processing
  - AIR FORCE LOGISTICS COMMAND: Logistical analysis and implementation
  - MAJOR COMMAND HEADQUARTERS: Safety monitor, legal and technical support, waiver review
  - AIR FORCE ENGINEERING AND SERVICES CENTER: Structural design of facilities
  - WING COMMANDERS: Safety responsibility, site planning, land acquisition
  - SECRETARY OF THE AIR FORCE: Waiver review
  - AIR FORCE SYSTEMS COMMAND: Planning and control, program management
  - HEADQUARTERS USAF: Requirements, budgeting, priority setting

RECOMMENDATIONS (#16)

The committee recommends that a coordinated program be established and that a systems approach be taken to plan and implement effective remedies to munition storage problems. While the committee has no consensus opinion on the management approach, we do recommend that the USAF explore various management options to determine the appropriate levels of program responsibility, budget authority, and management accountability.

Implementation of effective solutions will require the support of numerous mission organizations. This represents a significant management challenge.

RECOMMENDATIONS (#16)

1. ESTABLISH A MUNITION STORAGE PROGRAM, IMPLEMENT A SYSTEMS APPROACH, AND COORDINATE IT.

2. EXPLORE MANAGEMENT OPTIONS TO ACHIEVE THE APPROPRIATE LEVELS OF PROGRAM RESPONSIBILITY, BUDGET AUTHORITY, AND MANAGEMENT ACCOUNTABILITY.

ENHANCED STORAGE OPTIONS AVAILABLE

The remedies discussed in this report are summarized in this chart according to the timeframe in which they are expected to be applicable. Effective measures which will have significant benefit in the short term and are directly applicable to the current inventory can and are being taken. The committee believes these should be given highest priority. Wing commanders are resorting, by necessity, to waivers/risk management as a means of coping with the current problem. As other remedies are brought to bear, reliance on waivers should lessen.

In the intermediate term all but the desensitized HE approach can be directly applied to the existing stockpile. Only diverters and desensitized HE are considered to be solutions requiring high technology.

The availability of IHE or revolutionary concepts for efficient storage structures is believed to be 10 years into the future. These remedies depend on resolving certain technology unknowns and completing engineering development. The IHE based weapons will require extensive manufacturing process validation, weapon testing, and storage tests.

Implementation of near and intermediate term remedies in appropriate combinations have the potential of achieving the USAF on-base storage objective.

ENHANCED STORAGE OPTIONS AVAILABLE

	Short Term (1-2 Yrs)	Intermediate Term (3-5 Yrs)	Long Term (6-10 Yrs)
WAIVERS/RISK MANAGEMENT	x		
MODIFICATION OF Q-D CRITERIA	x		
COMPARTMENTALIZATION BY INERT PARTS/LOWER CLASS MUNITIONS	x		
COMPARTMENTALIZATION BY BLAST SHIELDS	x		
MECHANICAL DIVERTERS		x	
IN-GROUND VAULTS		x	
LAND ACQUISITION		x	
DESENSITIZED HE		x	
FACILITY HARDENING		x	
UNDERGROUND IGLOOS			x
INSENSITIVE HE			x

TASK STATEMENT

SUBJECT: Enhanced Non-Nuclear Munition Storage

PROBLEM: The threat analysis for the European scenario indicates that aircraft must be loaded inside shelters for survivability. Only a few shelters are constructed on sufficient real estate to provide adequate quantity-distance (Q-D) separation between the explosives and other essential base facilities. Risk to personnel, facilities, and equipment is significant. Additionally, storage facilities are not loaded to full capacity because of Q-D separation requirements. While new construction within restricted areas can proceed under waiver granted by the Service Secretary, risks must be reduced in order to make effective use of scarce real estate.

BACKGROUND: A proposed solution to the above stated problem is the development of an insensitive explosive which would replace the current tritonal fill in general purpose weapons. Such an effort has been undertaken at the Air Force Armament Laboratory (AFATL). Initial laboratory tests instilled confidence that AFX-400 (EAK) would meet insensitive high explosive (IHE) criteria and would be available in short term for MK-80 series fills. Scale-up testing, however, revealed serious deficiencies in meeting the IHE criteria. Investigation of alternate chemical solutions is ongoing at AFATL, and investigation of alternate storage/handling techniques promises some relief.

OBJECTIVES:

1. Review quantity-distance requirements for current and projected TAF stockpile of non-nuclear ordnance in the European Theater. Review current and projected storage capabilities and logistics doctrine as it affects operational capability.

2. Evaluate the impact of storage/handling regulations on operational capability both in peacetime and in conflict in the European environment.

3. Recommend improvements in handling and storage methods (including mechanical approaches) which would improve mission capability in the European environment. Consideration should be given to development of new explosives and/or possible modification of explosive safety requirements/regulations which would improve operational

capability without compromise of safety. Estimate the improvements in mission capability, manpower savings, or other benefits which would result from such modifications. Outline a plan to implement such modifications.

4. Review the current IHE development program and recommend changes, if any, which will improve chances for successful development of an insensitive explosive. In view of projected costs and manufacturing considerations, recommend a program for fielding such an explosive.

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STEERING COMMITTEE APPROVAL: 8 January 1985

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