

400 SERIES SUPPLY FACILITIES

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411 LIQUID FUEL STORAGE – BULK

411-1 GENERAL REQUIREMENTS

The availability of commercial facilities, intended service, and government resources (available developable area, security and safety of operations, and operation) should be considered as part of the overall planning process. Special care should be noted of site conditions to ensure design criteria can be met. This information can be found in the most current version of Unified Facilities Criteria Design: Petroleum Fuel Facilities (UFC 3-460-01), located on the Whole Building Design Guide (WBDG) website at the following link:

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

This document also provides information on the ancillary equipment associated with liquid fuel storage (i.e., pumping station, pipelines, etc.). These facilities will typically have separate category codes.

Note that the real property components associated with the category codes having FAC codes of 4111, 4112, and 4113 include the tanks and any containment structures associated with them, such as berms, liners, and monitoring wells. In the case of “cut and cover” type fuel storage under FAC 4113, the integral deep well turbine pumps are also included in the associated category codes and are not to be counted as separate real property assets.

411-2 STORAGE QUANTITIES

The quantities and types of petroleum products to be stored are based on consumption of fuels by the ships, aircraft, vehicles and equipment at the activities served and what type of delivery system that is utilized. Depot fuel storage facilities must be of sufficient capacity to provide an adequate operating and reserve supply of fuel for the activities served. A barrel is the standard 42 U.S. gallon capacity.

411-2.1 **Capacities.** For planning purposes, the capacities of individual tanks should be approximately 25% of the ultimate storage for each type of fuel, subject to the following:

411-2.1.1 The minimum capacity of a tank for fuel depot bulk storage shall not be less than:

- Diesel Fuel 13,500 barrels
- Fuel Oil 27,000 barrels

411-2.1.2 Standard tank sizes should be used.

411-2.1.3 A minimum of two tanks will be provided for each type of fuel. One will serve as the working tank and the other the receiving tank for new deliveries.

411-2.1.4 It is necessary for impurities in MoGas, AvGas and jet fuels to settle prior to the use. The time required for jet fuel to settle is one hour per foot of depth of the fuel in the tank.

411-3 CATEGORY CODES

The category codes in this section include fuel storage tanks of the following classifications: operational; bulk fuel; cut and cover; liquefied petroleum (LP); contaminated; and heating oil. CCNs 411-10 through 411-52 represent the fuel types associated with operational, bulk fuel, and cut and cover storage tanks. CCNs 411-60 through 411-84 represent the remaining fuel types associated with this section.

411 10 SHIP FUEL STORAGE 10K-100K (BL)

FAC: 4111

BFR Required: Y

411 11 SHIP FUEL STORAGE > 100K (BL)

FAC: 4112

BFR Required: Y

411 12 CUT AND COVER SHIP FUEL STORAGE (BL)

FAC: 4113

BFR Required: Y

411 20 AVIATION FUEL STORAGE 10K-100K (BL)

FAC: 4111

BFR Required: Y

411 21 AVIATION FUEL STORAGE > 100K (BL)

FAC: 4112

BFR Required: Y

411 22 CUT AND COVER AVIATION FUEL STORAGE (BL)

FAC: 4113

BFR Required: Y

411 30 DIESEL FUEL STORAGE 10K-100K (BL)

FAC: 4111

BFR Required: Y

411 31 DIESEL FUEL STORAGE > 100K (BL)

FAC: 4112

BFR Required: Y

411 32 CUT AND COVER DIESEL FUEL STORAGE (BL)

FAC: 4113

BFR Required: Y

411 40 MOTOR GASOLINE STORAGE 10K-100K (BL)

FAC: 4111

BFR Required: Y

411 41 MOTOR GASOLINE STORAGE >100K (BL)

FAC: 4112

BFR Required: Y

411 42 CUT AND COVER MOTOR GASOLINE STORAGE (BL)

FAC: 4113

BFR Required: Y

411 50 JET ENGINE FUEL STORAGE 10K-100K (BL)

FAC: 4111

BFR Required: Y

411 51 JET ENGINE FUEL STORAGE >100K (BL)

FAC: 4112

BFR Required: Y

411 52 CUT AND COVER JET ENGINE FUEL STORAGE (BL)

FAC: 4113

BFR Required: Y

DEFINITION. The fuel products in these category codes 411-10 through 411-52 are organized into three basic categories: operational fuel storage, bulk fuel storage, and “cut and cover” fuel storage. Operational storage tanks are designed with capacities between 10K and 100K BL; bulk storage tanks are designed with capacities greater than 100K BL; and “cut and cover” storage tanks are designed with capacities typically between 10K and 100K BL (these are operational tanks used in potentially hostile environments). Bulk fuel storage tanks are supplied by pipelines, tank trucks, or rail tanker cars. The bulk tanks in turn, supply operational fuel tanks and “cut and cover” storage tanks, which then supply the various fueling systems at an installation.

The Fleet Fuels Officer, Code N413F, within the US Fleet Forces Command in collaboration with Defense Logistics Agency’s (DLA) Defense Energy Support Center (DESC) Code B (Bulk Fuels) will determine the fuel storage requirement. Design guidance, including safety features, can be found in the most current version of Unified Facilities Criteria Design: Petroleum Fuel Facilities (UFC 3-460-01), located on the Whole Building Design Guide (WBDG) website at the following link:

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

Note that the real property components associated with the above category codes include the tanks and any containment structures associated with them, such as berms, liners, and monitoring wells. In the case of “cut and cover” type fuel storage, the integral deep well turbine pumps are also included in the associated category codes and are not to be counted as separate real property assets.

411 60 LIQUEFIED PETROLEUM GAS STORAGE (BL)

FAC: 4111

BFR Required: Y

41160-1 **DEFINITION.** The Navy uses liquefied petroleum gas, commonly known as LPG, for heating, metal cutting, brazing, in dental laboratories, aboard ships, and in similar installations. LPG consists predominantly of propane, propylene, with minor amounts of butane, isobutene, and butylenes.

41160-2 **REQUIREMENT.** LPG is normally supplied in 100-pound cylinders or delivered by tanker truck or train car. The bulk storage capacity requirements for LPG depend on activity requirements, frequency of deliveries, and dependability of supply as well as lack LPG on base operations. Historical data is a good resource for developing a requirement looking for predictable changes in demand (i.e., loss of metal shop, increase in ship homeporting, increase in local dental operations, etc.). Otherwise, review equipment specifications for consumption rate as well as equipment usage to determine basic requirement. Again, allow for impacts from delivery schedules and dependability. Design guidance, including safety features, can be found in the most current version of Unified Facilities Criteria Design: Petroleum Fuel Facilities (UFC 3-460-01), located on the Whole Building Design Guide (WBDG) website at the following link:

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

411 70 VAPOR EMISSION CONTROL SYSTEM (EA)

FAC: 8999

BFR Required: Y

41170-1 **DEFINITION.** The vapor collection and recovery system is provided for tanks that store products having a true vapor pressure of 0.75 psia (5kPa) or more and located in air pollution control areas in which discharge of petroleum vapors is controlled or prohibited. Check with the depot and environmental personnel to determine if system is required.

411 82 CONTAMINATED FUEL STORAGE (BL)

FAC: 4111

BFR Required: Y

41182-1 **DEFINITION.** A fuel storage facility requires temporary storage for off-specification (contaminated) fuel.

41182-2 **REQUIREMENT.** Separate tanks should be provided for each type of fuel stored and consumed in large quantities. Review historical data to determine typical volume of delivery and method and schedule of disposal to determine tank size.

411 84 BULK (DEPOT) HEATING FUEL STORAGE (BL)

FAC: 4111

BFR Required: Y

41184-1 **DEFINITION.** Heating fuel oil storage may include storage tanks for kerosene and several different grades of diesel oil.

41184-2 **REQUIREMENT.** The station's requirements and mission will determine the quantity of any type of heating fuel oil stored. Some bases may rely on contract deliveries versus depot support. In these instances, depot storage should not be provided.

412 LIQUID STORAGE OTHER THAN WATER, FUEL AND PROPELLANTS**412-1 GENERAL DESCRIPTION**

This group includes tank storage, accessories and piping for organic liquids such as cottonseed, linseed or soybean oils and other non-fuel liquids such as lubricants, ballast, or waste oils. Historical data should be available to determine rate of delivery and storage requirement. For waste liquids and oils, methods and schedule of disposals should be considered when determining storage requirement.

412-2 STORAGE QUANTITIES

No specific planning factors for the following category codes are currently available. Historical data may be used to develop the basic requirement including review of delivery schedules and removal of materials. Method of delivery/removal (i.e., pipeline to barge, truck, etc.), maximum quantity delivered/removed (is incoming quantity greater than outgoing quantity) and frequency (how often is material delivered to tanks and how often is material taken from tank) should also be considered.

412-3 CATEGORY CODES

The individual category codes in this group are shown below:

412 15 ROAD OIL STORAGE (GA)

FAC: 4121

BFR Required: N

412 25 LUBRICANT STORAGE (GA)

FAC: 4121

BFR Required: N

412 35 BALLAST AND SLUDGE STORAGE (GA)

FAC: 4121

BFR Required: N

412 40 ORGANIC OIL STORAGE (GA)

FAC: 4121

BFR Required: N

412 45 MISCELLANEOUS LIQUID STORAGE (GA)

FAC: 4121

BFR Required: N

412 50 INDUSTRIAL/POL WASTE STORAGE FACILITY (GA)

FAC: 4121

BFR Required: N

420 AMMUNITION STORAGE**420-1 DEFINITION**

Ammunition storage utilizes magazines, general purpose and refrigerated storehouses, tanks, open storage pads and associated stationary equipment for storage of Ammunition, Inert Ammunition Components, Liquid Propellants and Weapon-Related Batteries.

Category groups pertaining to these facilities are as follows:

Code 421	Ammunition Storage at Weapons and Other Stations (Tables 420-1 thru 420-19)
Code 423	Ammunition Storage - Liquid Propellants (Tables 420-20 thru 420-25)

Code 424 Weapon-Related Battery Storage
Code 425 Open Ammunition Storage

420-2 GENERAL STORAGE REQUIREMENTS

Ammunition and bulk explosives should be stored in magazines of approved design, sited and designated for specific purposes. The type and amount of material that may be stored in any magazine is dependent on the quantity-distance requirements and permissible storages as established by the Department of Defense Explosives Safety Board (DDESB) and as approved by the Naval Sea Systems Command. These safety distance requirements are designed to provide the inhabitants of nearby communities, military personnel, and adjacent public and private property reasonable safety from injury or destruction from possible fires or explosions, and to keep to a minimum the loss of valuable ammunition stores through fire or explosions.

420-3 MAGAZINE AREA

The magazine area is the area surrounding a magazine or group of magazines, where personnel movements are restricted in the interest of safety. Magazines must be sufficiently remote from inhabited buildings, passenger railroads, and public highways, including navigable waters, so that the dangers and risks involved in storing explosives and ammunition are confined primarily to the magazine area. In order to insure this safety zone the Department of Defense Explosive Safety Board has spacing criteria for magazines, based on the type of hazard involved and the quantity of explosives stored. See Naval Sea Systems Command Publication NAVSEA OP-5 Volume 1 (current revision) for Quantity-Distance Requirements. In the case of existing facilities, spacing criteria may limit the amount of explosives stored in a magazine to less than full capacity. In addition, limits have been set on the maximum amount of explosives that can be stored in certain types of magazines. This information is listed in the category code descriptions.

420-4 SEGRAGATION OF MATERIALS

The dangers or hazards involved in the storage of ammunition or explosives are not measured solely by the quantity of explosives stored, but also by its sensitivity - explosives that present similar hazards may generally be stored together.

Tables showing compatibility relationships can be found in the Naval Sea Systems Command Publication OP-5, Vol. II (current revision).

420-5 WEIGHT MEASUREMENT

Two systems of weight measurement are significant in planning for ammunition storage:

- (a) Net Explosive Weight. (hereafter referred to as NEW). This is the weight of explosive material, and is measured in pounds. In items of ammunition with a high explosive main charge, fuses containing ignition

explosives, and a propelling charge of smokeless powder, the NEW is calculated in accordance with NAVSEA OP-5 Vol. I, Chapter 5. It is the net explosive weight in a stow of ammunition or bulk explosives that is used in application of explosive safety quantity-distance (ESQD) tables.

(b) Gross Explosive Weight. The gross explosive weight of an item of ammunition, bomb, rocket, etc., is the total weight of the packaged round and is measured in short tons or pounds when quantities are fractional tons. Packaging may vary, therefore, planning factors, too, may vary slightly in published data. Attention must be given to the unit of measure as long tons and measurement tons may be used by other services and in ship loading

420-6 PLANNING FACTORS

Planning factors, where available, are listed under the appropriate category code number. All planning factors in the 421 category code are given in terms of net area which is the nominal inside area of a structure. The planning factors listed are average figures based on large volumes of explosives of variable composition. Where a facility has a small amount of ammunition storage or a limited diversity in types of ammunition, the planning factors may give inaccurate results. Under these circumstances, planning factors may be developed in the field. Naval Sea Systems Weapons Requirement WR Series contain data listing size and weight of ammunition in storage containers, and may be useful in developing planning factors. Only the magazine space that can be utilized without exceeding the explosive limit shall be considered when evaluating existing magazines for planning purposes. Caution must be exercised in the planning process because Real Property Inventory and Shore Facilities Planning System (SFPS) documentation will show the actual facility asset quantities.

420-7 APPROVED BASIC STOCK LEVEL OF AMMUNITION (ABSLA)

This document is prepared by the Naval Sea Systems Command (Code NSEA 04511) for major ammunition stock points, such as torpedo stations, weapon stations, etc., and secondary stock points such as naval stations, naval air stations, etc. The quantity of ammunition detailed within this document constitutes the ABSLA for a particular activity, and is compiled in accordance with the guidance set-forth in OPNAVINST C 8010.12C. In addition to this instruction, guidance is also provided by the current USPACFLT, USFF or Non-Nuclear Ammunition Distribution Plan, whichever is applicable to the activity.

Ammunition storage capacity in the activity's ABSLA is tabulated in terms of standard equivalents and is based on a comparison of the actual floor area with a standard square footage developed for each magazine type: High explosive magazine type A, 25' x 80'; smokeless powder and projectile magazine type L/P, 50' x 100'; fuse and detonator magazine type F, 25' x 20'; and inert storehouse type SH, 50' x 200'. See NAVSEA OP-5 Vol. I, Chapter 6.

The storage capacity analysis in the ABSLA is based on generalized planning factors. Actual capacity is dependent upon the mix of ammunition on hand and the locally developed storage plan which must consider hazard classes of ammunition, compatibility, quantity distance constraints, type of stow utilized and other local patterns of operations. Storage requirements for the items included in the ABSLA are computed utilizing the definition for access stow, i.e.; every pallet accessible for observation and every stack attainable with a fork lift truck after moving not more than three other stacks of pallets. Twenty percent of the net storage space is allocated for aisles, explosives compatibility, lot control, etc., coastal POE or tidewater activities due to periods of volume transactions of ammunition which require additional "elbow room". This space allowance allows for constant turnover and restorage operations inherent in ammunition handling which makes the utilization of the full space of the magazines unattainable as a practical matter. This analysis assumes that bombs and mines are "JAM", or maximum stowed versus access stow. The space utilization factors used in the ABSLA should be considered upper limits of utilization.

The ABSLA for a specific activity provides the following information for the storage of non-nuclear ammunition:

- a. Amount and type of ammunition to be stored.
- b. Type of magazines used for storage: high explosive, smokeless powder and projectile, fuze and detonator and inert storehouse.
- c. Theoretical number of magazines required for each type.
- d. Magazines available for each type.
- e. Net magazine space for each type of magazine that is available after 10% - 20% has been deducted. Percentage of availability depends upon mission of activity.
- f. Excess/Deficit (net available facilities minus total facilities required) requirements for each type of magazine.

Stow factors can be developed for H.E. munitions in H.E. magazines, SP&P munitions in SP&P magazines; etc., which express in percent utilization of the net magazine space, or tons/sq. ft. or other factors. For example, the Indian Island ABLSA, less bombs and missiles, has a density of 51.4 lbs/cu.ft., i.e., S/T ratio, M/T is 1.03 which is commensurate with shiploading experience.

Inert material density is 35.2 lbs/cu.ft.

Definitions:

- a. Gross storage space - outside dimensional area of storage structure.
- b. Net storage space - inside dimensional area of storage structure.
- c. Available storage space - net space X factor which allows for handling room, stow configuration, aisles, etc. Factor varies from 0.4 to 0.75.

Reports of utilization of magazines should compare available storage space with actual stow. However, in reporting un-utilized space, care must be taken not to add fractional magazines of different or non-compatible ammunition. Missile magazine utilization should be based upon area rather than volume since stack heights are controlled and the void above a missile stack is not available space.

420-8 SPACE UTILIZATION

Utilization of igloo and magazine space will seek optimum occupancy level of 90 percent of net storage space available when such occupancy is not in conflict with regulatory directives concerning compatibility and safety distances. However, in performing fleet service operations at coastal weapons stations, magazine net space utilization factors of 25% to 60% may be considered good. Comparable cube efficiency would be 58% for inert material stows in SH structures. An average density of ammunition can be computed from the ABSLA applicable to a given ammo storage facility and planning factors (sq.ft./ton) determined. A density of 64.2 lbs/cubic ft is representative of gun ammunition carried as cargo by AE/AOE ships. A useful storage factor thus derived is: 8.5 to 11 square feet per ton per standard size magazine for SP&P type material. Additionally, ammunition storage space occupancy will attain the following storage densities:

1. Conventional ammunition - 10 square feet of gross storage space per short ton.
2. Special munitions - 10 square feet of net storage space per short ton.
3. Chemical, biological and radiological munitions - 29 square feet of gross storage space per short ton.
4. Guided missiles and large rockets - 26 square feet of gross storage space per short ton.

420-9 TYPES OF MAGAZINES

In the past, a distinction was made between depot and installation magazine storage requirements. At most ammunition activities, with a combined depot and installations mission, the ammunition stored in support of such dual missions was commingled and stored in the same magazines in a single location. Consequently, it was usually difficult to feasibly separate the two functions for inventory and evaluation of existing facilities purpose. Therefore the 422 Basic Category series has been discontinued and all ammunition magazines and storehouses in the 420 category group will be classified under Basic Category 421.

420-10 CONTAINERIZED AMMUNITION

FAC: ?

BFR Required: ?

Implementation of directives for containerizing ammunition for shipment is now underway at certain ordnance activities, initially at coastal POE's. For these activities, new category codes and planning factors have been developed to facilitate proper identification and sizing of the facilities that are in support of containerized ammunition shipments. The following new category codes and planning factors are established for handling of ammunition by containers. As warranted, additional category codes and planning factors will be developed.

149 82	Container Holding Yard (Loaded)
149 83	Container Transfer Facility
149 84	Rail/Truck Receiving Station
151 70	Ordnance Container Handling Pier
152 70	Ordnance Container Handling Pier
153 30	Container Stuffing Building
218 10	Container Repair and Test Building
425 20	Container Holding Yard (Empty)
860 20	Explosive Barricade for Suspect Trucks and Railroad Cars

420-11 QUANTITY-DISTANCE REQUIREMENTS

FAC: ?

BFR Required: Y

See Naval Sea Systems Command publication NAVSEA OP-5, Volume 1 (current revision) for quantity-distance requirements.

421 AMMUNITION STORAGE DEPOT AND INSTALLATION

421-1 DEFINITION

Ammunition storage utilizes magazines or other suitable structures to store ammunition for the ultimate user's logistic flexibility at an activity. Planning factors are provided for the following types of ammunition storage facilities:

421 12	FUZE AND DETONATOR MAGAZINE
421 22	HIGH EXPLOSIVE MAGAZINE
421 32	INERT STOREHOUSE
421 35	READY MAGAZINE
421 42	SMOKEDRUM STOREHOUSE
421 48	SMALL ARMS/PYROTECHNIC MAGAZINE
421 52	SMOKELESS POWDER PROJECTILE MAGAZINE
421 62	SPECIAL WEAPONS MAGAZINE
421 72	MISSILE MAGAZINE

421 12 FUZE AND DETONATOR MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42112-1 **DEFINITION.** Primers, fuzes, detonators, and boosters of all types are stored in fuze and detonator magazines. These magazines are of the following types:

- (1) 10' x 14' box-type, earth covered and barricaded. 15,000 lbs NEW Type H.
- (2) 25' x 20' arch-type, earth covered. 70,000 lbs NEW Type F.

A planning factor of 7.9 SF net storage space per short ton gross weight of explosives may be used for storage or tidewater activities, provided the conditions are as stated in paragraph 5, under general narrative for basis Category Group 420. Planning for installation storage is done on an individual activity basis with space requirements being determined from the particular components to be stored at an activity. In the absence of adequate data the total area of installation fuze and detonator magazines can be planned as between 4 and 6% of the total area of high explosive magazines at the activity.

421 22 HIGH EXPLOSIVE MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42122-1 **DEFINITION.** A high-explosive magazine is used for the storage of mass-detonating explosives. Bomb, warheads, naval mines, demolition charges are examples of munitions generally stored in high explosive magazines. Types of magazines commonly found at coastal depots are:

- (1) 25' x 80' arch-type, earth covered and barricaded. 500,000 lbs NEW Type A.
- (2) 39' x 44' and 32' and 44' box-type, earth covered and barricaded. 500,000 lbs NEW Type W. Especially developed for torpedo storage in racks.
- (3) 25' x 50' arch-type, earth covered and barricaded. 250,000 lbs NEW Type B.

A planning factor of 7 square feet net storage space per ton gross weight of ammunition may be used.

421 32 INERT STOREHOUSE (SF)

FAC: 4211

BFR Required: Y

42132-1 **DEFINITION.** Storehouses for inert material are usually 50 x 200 ft. or 106 x 204 ft. or multiples of these basic dimensions, and are similar to commercial warehouses. These storehouses are used for the storage of such non-explosive items as bomb tails, machine gun links, empty cartridge cases, and packing materials. Although the height of stowage in these storehouses depends on the type materials, the average stacking height is about 10 feet. Storage space available for storage will meet a minimum criteria of 60 percent of net storage space used for storage operations. The net storage capacity of the 50 x 200 ft. storehouse is approximately 60,000 cubic feet.

For planning of installation inert storehouses use only the 50 x 200 ft. storehouse.

421 35 READY MAGAZINE (SF)

FAC: 4221

BFR Required: Y

42135-1 **DEFINITION.** This category code and nomenclature encompasses three specific types of magazines whose requirements are determined by the function performed. The three types of magazines within this category code are identified as:

- (a) **Ready Service Magazine.** When shore establishments require certain types of ammunition to be stored in a ready service condition, in order to reduce the arming time, the ammunition may be stored in designated Ready Service Magazines. This facility is usually located at an air station and is used to hold ammunition and/or weapons that are built up from a storage configuration ready for arming an aircraft, or to receive for temporary storage, ammunition and/or weapons from aborted aircraft. The average utilization of available floor space is traditionally 40 percent since the material stored is varied and not packaged for storage. A planning factor of 40 square feet of net storage space per ton of gross weight of ammunition is used for this type of magazine. A 12' x 17' box-type magazine is suit able for performing this function.

- (b) **Ready Service Locker.** This type of magazine is generally used to store small quantities of belted or boxed small-arms ammunition, certain pyrotechnics, and similar fire, no blast hazard material. It is not practical to derive a meaningful square foot per ton planning factor for the material that might temporarily be stored in this facility. However, a 6' x 8' Keyport magazine is quite suitable to perform this function and has the added benefit of being able to be secured. Historical data should be used to determine the number of these facilities required which is not only dependent upon the amount of explosives stored but also the compatibility of the explosives themselves.

- (c) **Special Service Magazine.** This type of magazine is provided in or near such facilities as loading plants, filling houses, weapon assembly buildings, ammunition maintenance buildings and Weapon Quality Evaluation Laboratories. The magazine can be a special size and construction, depending upon the material(s) stored therein. However, a 6' x 8' Keyport magazine has been found to be most suitable for this application. The need to provide segregation of non-compatible, open explosives frequently gives rise to a requirement for separate magazine structures, irrespective of any loading factor. Consequently, no meaningful planning factor relating to square feet to a quantity of ammunition are available for this type of magazine. Historical data should be used to determine the number of these facilities required which is dependent upon both the amount of explosives stored and the compatibility of the explosives themselves.

421 42 SMOKEDRUM STOREHOUSE (SF)

FAC: 4211

BFR Required: Y

42142-1 **DEFINITION.** Chemical and smoke mixtures are stored separately in fire-hazard type magazines or in buildings especially designed for such storage. Drums of smoke mixture may be stored in surface buildings with special racks for support, and overhead equipment for handling. Smokedrums storehouses are of the sizes and capacities shown in Table 42142-1.

**Table 42142-1
Smokedrum Storehouses**

Size Number	Capacity (Drum)	Approximate Bldg Dimensions In Feet				
		W		L		H
1	120	25	x	17	x	14
2	240	25	x	34	x	14
3	360	25	x	51	x	14
4	480	25	x	58	x	14

For more than 480 drums, two or more buildings should be provided.

421 48 SMALL ARMS/PYROTECHNICS MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42148-1 **DEFINITION.** This structure may be used to store Class 1 Division 3 and 4 ammunition. This type of magazine may vary considerably in size and description. The standard earth-covered concrete arch magazine without barricade and the non-earth covered two compartment magazine are commonly used for this purpose. If the land area is limited and there is a large requirement for small arms/pyrotechnics storage space, the large triple arch magazine maybe used. The triple and standard arch-type magazines shall be planned using a factor of 7.0 SF net storage space per ton gross weight of explosives, provided for the conditions are as stated in paragraph 5, under general narrative for basis Category Group 420. The two compartment magazine is usually restricted to the storage of Class 1 Division 3 and 4 and is planned on an individual basis. For ammunition class descriptions, see OPNAVINST 8020.8.

421 52 SMOKELESS POWDER PROJECTILE MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42152-1 **DEFINITION.** The smokeless powder projectile magazine is used for the storage of smokeless powder, pyrotechnics, rocket motors, rocket heads, loaded projectiles, fixed ammunition, small-arms ammunition, and other fire (Class 1 Division 2) or missile hazard material. The magazines are of two general classifications:

1. Rectangular, concrete earth-covered magazines:
 - Type I, 52 x 103 feet
 - Type IIA, 52 x 161 feet
 - Type ILB, 52 x 97 feet
2. Concrete triple-arch earth-covered magazine which consists of three barrels, each 25 x 80 feet.

A planning factor of 11.0 SF net storage space per ton gross weight of explosives shall be used provided the conditions are as stated in paragraph 5, planning factors under general narrative for basic Category Group 420.

421 62 SPECIAL WEAPONS MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42162-1 **DEFINITION.** The special weapons magazine is the same type of structure as the high explosive magazine and differs only in that it is used for the storage of nuclear weapons. Magazines used for the storage of special weapons are subject to quantity-distance requirements and are limited to the maximum amount of nuclear material that can be stored in any one magazine. This information, along with the sizes and weights of nuclear weapons and security requirements can be obtained from:

- (S) SWOP 20-7, NUCLEAR SAFETY CRITERIA (U)
- (S) SWOP 50-1, NUCLEAR ORDNANCE GENERAL INFORMATION (U)
- (C) OPNAVINST C5510.83 SERIES, CRITERIA AND STANDARDS FOR SAFEGUARDING NUCLEAR WEAPONS (U)

Planning data for Category Code 421 62 related to specific locations will be classified in accordance with cognizant Navy directive. A planning factor of 10 SF net storage space per ton gross weight of explosives shall be used provided the conditions are as stated in paragraph 5, planning factors under general narrative for basis Category Group 420.

421 72 MISSILE MAGAZINE (SF)

FAC: 4211

BFR Required: Y

42172-1 **DEFINITION.** Missile magazines are generally rectangular earth-covered concrete magazines in which assembled missiles are stored. When missiles are stored

unassembled, guided missile motors are stored in the smokeless powder projectile magazine and the warheads are stored as high explosives. Missile magazines have special door sizes and interior column spacing to facilitate ease of storage and handling of the assemble missiles. The smokeless powder projectile and high explosive magazines can be used for the storage of assembled missiles but their layout and size may physically restrict the number of missiles stored. Table 421-72 lists the common Navy surface and air-launch guided missiles along with the sizes of storage containers and appropriate planning factors. The example in figure 421-72 illustrates the use of Table 42172-1.

The gross area per stack of containers is derived from the following assumptions:

- walls of magazine occupy 10% of total area
- 63% of magazine is available for storage
- 80% of available storage utilized

The conversion from net area to gross area is:

$$\text{SF (Gross) per stack} = \frac{\text{SF (Net) per stack}}{.63 \times .8 \times .9}$$

See Figure 421-72 for sample computation.

**Figure 421-72
Sample Computation for Missile Magazine**

EXAMPLE: Determine the gross area required to store 38 PHOENIX MISSILES. Containers will store two missiles.

Refer to TABLE 421-72:

Using the columns (1) and (4) locate row which contains factors for PHOENIX MISSILE when stored two missiles to a container. Moving across this row, the table indicates that three containers may be stacked (Column 6) and that each stack requires a gross area of 97.7 SF/stack (Column 8).

COMPUTATIONS:

$$\frac{2 \text{ missiles}}{\text{container}} \times \frac{3 \text{ containers}}{\text{stack}} = \frac{6 \text{ missiles}}{\text{stack}}$$

$$38 \text{ missiles} \div \frac{6 \text{ missiles}}{\text{stack}} = 6.33 \text{ stacks}$$

Need 7 stacks (rounded to next whole number)

$$\text{Gross Area} = \frac{98.4 \text{ SF}}{7 \text{ stacks}} \times \text{stack} = 689 \text{ SF}$$

TABLE 421-72
Planning Factors - Missile Storage

(1) Missile	(2) Container MK-MOD	(3) Storage Container Dimensions (Inches)			(4) No. of Missiles per Containers	(5) Gross Weight Containers Plus Missile (pounds)	(6) No. of Containers Stacked (recommended)	(7) SF (NFI) per Stack	(8) SF (CPCSS) per Stack .45
		L	W	H					
ASROC RUM-5 MODS	183-2	195.0	29.0	33.0	1	1,700	4	39.3	87.3
BULLPUP/A	MK 441	147.0	24.0	26.0	1	1,100	2	24.5	54.4
BULLPUP/B	MK 443	182.0	29.0	33.0	1	2,370	3	36.7	81.6
CONTOR	CNU-220/E	178.0	29.0	34.0	1	2,597	2	35.9	79.6
HARM G.M. AGM-88	CNU-295/E	178.0	36.0	28.0	1	2,500	2	44.5	98.9
HARBORN ASROC RCM-84A-1	608-0	207.0	29.0	37.0	2	2,500	3	41.7	92.7
HARBORN TARTAR RCM-84A-2	632-0	193.5	28.0	28.5	1	2,500	3	37.6	83.6
HARBORN CARISSTAR RCM-84A-1B	631-0	217.0	45.5	47.0	1	3,200	2	68.9	152.4
HARBORN CAPSULE UGM-84A-1	630-0	271.5	44.0	36.0	1	3,667	2	81.0	184.4
HARBORN G.M. UGM-84A-1	607-0	168.0	33.8	37.6	2	3,400	2	44.1	98.0
PHOENIX AIM-54A	CNU-124/E	168.0	38.0	29.0	2	2,649	3	44.3	98.4
PHOENIX AIM-54	CNU-242/E	168.0	38.0	30.0	2	2,925	3	46.3	98.4
SHRIKE AGM-45	Cradle 14-0	141.0	36.0	28.0	3	1,710	6	35.3	78.4
SHRIKE AGM-45	399-0	142.0	16.0	18.0	1	665	10	15.8	35.1
SHRIKE AGM-45	CNU-167/B	141.0	36.0	25.0	3	1,796	6	35.3	78.4
SIDEWINDER AIM-9	16-0	136.0	31.0	19.0	4	1,359	5	34.0	75.6
SPARROW III AIM-	Cradle	160.0	36.0	28.0	3	1,703	6	40.0	88.4
SPARROW III AIM-7 (WDSMS)	MK 12-0								
SPARROW III AIM-7 (WDSMS)	CNU-166/E	159.0	36.0	26.0	3	1,972	6	30.8	68.4
SPARROW	MK 470-0	156.0	21.0	21.0	1	777	3	22.8	50.7
STANDARD/ARM	MK 372-4	203.0	28.0	29.0	1	2,020	4	39.5	87.8
STANDARD/ARM	CNU-183/2	194.0	28.0	29.0	1	2,050	4	37.7	83.6
STANDARD/ARM AGM-78 A,B,C,D	CNU-121/F	203.0	29.0	32.0	1	2,100	4	40.9	90.0
STANDARD/HR	MK 372-2B1	203.0	28.0	29.0	1	2,210	3	39.5	87.8
TALOS	MK 264-0	276.0	46.0	50.0	1	4,900	2	88.2	196.0
TALOS BOOSTER	MK 276-0	155.0	40.0	48.0	1	5,435	1	43.1	95.6
TARTAR RTM MK 61 MODS	372-3,4,6	203.0	28.0	29.0	1	2,110	4	39.5	87.8
TARTAR RTM-24 Missile	372-3,4	203.0	28.0	29.0	1	2,110	4	39.5	87.8
Tactical									
TARTAR PIM-66 Std. Missile (MR)	372-5	203.0	28.0	29.0	1	2,110	4	39.5	87.8
TARTAR Std. ARM SSM	372-5	203.0	28.0	29.0	1	2,110	4	39.5	87.8
TERRIER RHM-2 Missile	199-0,1	187.0	27.0	30.0	1	1,870	3	35.1	78.0
TERRIER BOOSTER MK 12	200-0,1	167.0	27.0	30.0	1	2,591	3	31.3	69.6
TERRIER RHM-67 Std. Missile	199-0,1	187.0	27.0	30.0	1	1,870	3	35.1	78.0
TORNADAW TASM	Not Assigned	276.0	36.0	42.0	1	6,000	-	69.0	153.1
TORNADAW TASM	Not Assigned	276.0	36.0	42.0	1	6,000	-	69.0	153.1
WALLEYE MK 1-0	Cradle 13-0	150.0	38.0	34.0	2	2,925	2	39.6	88.0
WALLEYE MK 1-0	426-0	154.0	30.0	32.0	1	1,602	4	32.1	71.5
WALLEYE MK 5 MODS	CNU-154/E	172.0	29.0	33.0	1	2,905	2	34.6	76.9
WALLEYE MK 13 MODS	CNU-154-E	172.0	29.0	33.0	1	2,905	2	34.6	76.9
WALLEYE MK 23 MODS	CNU-154/E	127.0	29.0	33.0	1	2,905	2	34.6	76.9

421 82 SUBMARINE LAUNCHED BALLISTIC MISSILE STORAGE FACILITY (SF)

FAC: 4212

BFR Required: Y

42182-1 No criteria are currently available for this Category Code.

423 AMMUNITION STORAGE – LIQUID PROPELLANTS

423-1 DEFINITION

The siting of liquid propellant (energetic liquids) storage facilities and the amount of propellant that can be stored are subject to strict safety criteria due to the fire and/or detonation hazards involved. Factors such as the degree of hazard and the compatibility of propellants stored in close proximity to each other affect the spacing of storage facilities and the amount of propellant that can be stored. NAVSEA OP-5 Vol. 1, Ammunition and Explosives Ashore provides criteria on hazard classification, quantity-distance tables, storage compatibility, and explosive equivalents.

423 10 LIQUID PROPELLANT STORAGE (GA)

FAC: 4231

BFR Required: Y

42310-1 **DEFINITION.** Storage vessel dimensions along with relevant siting requirements can be used to develop facility requirements.

423 20 LIQUID PROPELLANT DISPENSING FACILITY (GM)

FAC: 1221

BFR Required: Y

42320-1 **DEFINITION.** Liquid propellant storage and dispensing facilities shall satisfy the operational requirements of the particular command within whose jurisdiction the facilities are located.

424 WEAPON-RELATED BATTERY STORAGE

424-1 DEFINITION

Weapon-related storage utilizes refrigerated warehouses that are capable of maintaining at least subfreezing temperatures. This code is not to be used for other cold storage facilities.

424 10 WEAPON-RELATED BATTERY STORAGE (SF)

FAC: 4241

BFR Required: Y

42410-1 **DEFINITION.** Storage requirements can be determined from the quantity to be stored and the types of equipment used to rack and stack the batteries.

425 OPEN AMMUNITION STORAGE

425-1 **DEFINITION.** Provides open hardstands (pavements or prepared/stabilized surfaces) for ammunition storage and excludes all other hardstands.

425 10 OPEN AMMUNITION STORAGE PAD (SY)

FAC: 4251

BFR Required: Y

42510-1 **DEFINITION.** Refer to NAVSEAOP-5 Vol. 1 for regulations governing open storage of explosive material. Ordnance open storage is undesirable.

425 20 CONTAINER HOLDING YARD (EMPTY) (SY)

FAC: 4251

BFR Required: Y

42520-1 **DEFINITION.** An empty ISO container-holding yard should be capable of storing at least one full container shipload plus 1/3 more. As the pipeline becomes full of containers, each container ship will discharge one container for each one loaded. Additionally, empty containers awaiting testing, repairs, stuffing or shipment to inland points will be on hand. Assuming a single berth pier/wharf for a 750 container ship, planning for an empty container-holding yard should be for 1,000 empty containers. See Figure 42520.1 for a typical 1,000-container yard layout. Total area of the holding yard is 19,180 SY. Size is predicated on 8' x 8' x 20' containers stacked three high. Containers are handled with container handling equipment or straddle carriers.

Figure 42520.1-Typical 1,000 Container Yard Layout

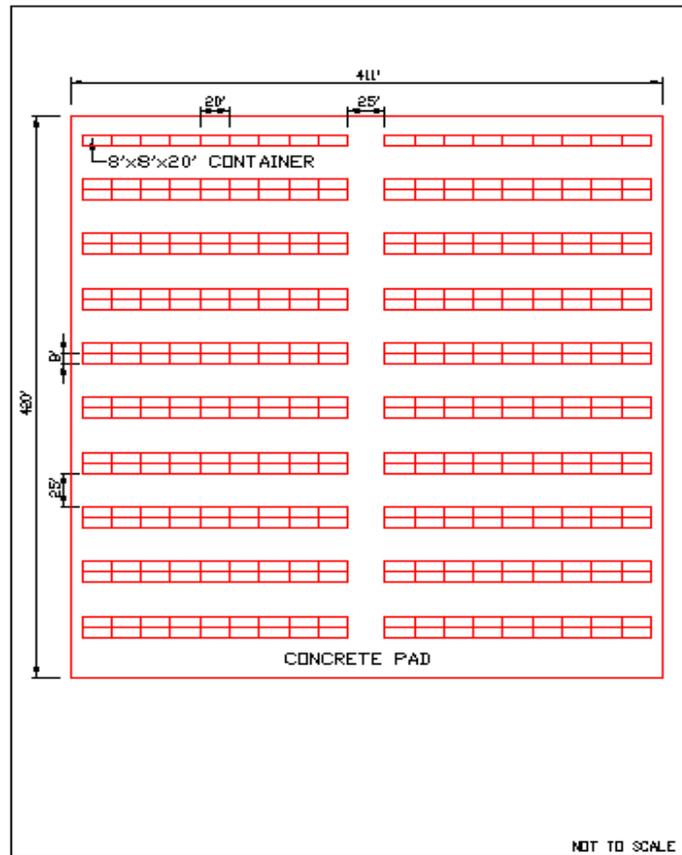


FIGURE 425-E0
CONTAINER HOLDING YARD (EMPTY)

425 30 BARRICADED MODULE (SY)

FAC: 4251

BFR Required: Y

42530-1 **DEFINITION.** A barricaded module is a barricaded area comprising of a series of connected cells with hard surface storage pads separated from each other by barricades. A light shed-type metal roof or fire retardant tarpaulin installed in a manner to provide sufficient ventilation between the tarpaulin and the stored ammunition may be used to cover the individual cells. Heavy structures or flammable materials will not be used for this purpose.

The maximum net weight of explosives permitted to be stored within each cell is 250,000 pounds. Storage pads should be hard surfaced, if possible, in order to minimize the effects of earth shock from an accidental explosion. No restrictions are imposed upon the arrangement of cells within a module or upon the arrangement of groups of modules, except that all cell openings will not be faced toward each other unless they are barricaded or meet the standard quantity-distance criteria for un-barricaded above ground magazines. See Figure 42530.1 for typical module layout. See NAVSEA OP-5 for site restrictions and facility design requirements.

Figure 42530.1 Typical Module Layout

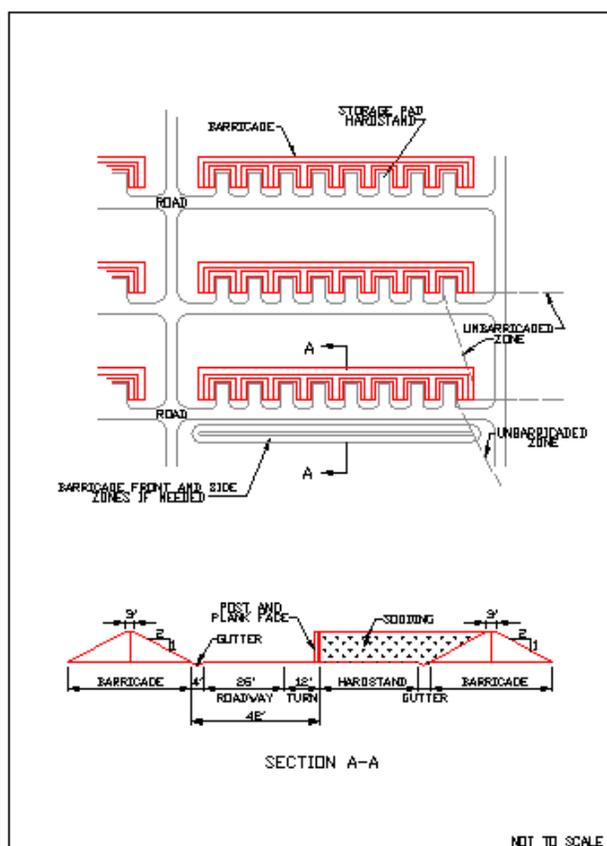


FIGURE 425-30
TYPICAL ARRANGEMENT OF EIGHT-CELL MODULES

430 COLD STORAGE

430-1 DEFINITION

Cold storage is planned to provide refrigerated warehouses for storage of General Supply Materials which require temperatures ranging from -10°F to 60°F in the following categories:

- Perishable Substances
- Photosensitized Material
- General Supply Batteries
- Medical and Dental Supplies

430-2 EXCLUSION

Excluded from this category group are cold storage for weapons-related batteries (use Category Code 424 10) and cold storage spaces that are a functional part of another facility such as an open mess, club, hospital, commissary or exchange. These cold storage spaces are planned as part of their respective main facilities and are accommodated within its space allowances.

430-3 OTHER APPLICABLE REQUIREMENTS

In most CONUS locations, Cold Storage Facility requirements have been all but eliminated through changes in supply business processes. Direct Vendor Delivery contracts provide such materials directly to end users in an as needed frequency required to effectively transfer the related warehousing from the public to the private sector vendors. These requirements guidelines are provided for those missions who do require an installation or area storage facility to hold some measure of items requiring cold storage.

430-4 STORAGE OF FARINACEOUS AND HIGH ACID FOOD PRODUCTS

These food products are properly stored in an environment where the temperature is between 50 and 70 degrees Fahrenheit. A cold storage warehouse will be required to provide chill storage at those activities where climatic conditions preclude the use of a general purpose warehouse.

431 10 COLD STORAGE WAREHOUSE (SF)

FAC: 4311

BFR Required: Y

43110-1 **DEFINITION.** A cold storage warehouse is planned to preserve the quality of perishable foods and general supply materials that require refrigeration. The warehouse will include freeze and chill space and normal processing facilities and mechanical areas. The space requirements are applicable to cold storage facilities of all sizes whether built as separate structures or in conjunction with other buildings and are determined by using the criteria furnished in the BFR guidance above. For installations with such requirements, correlated to loading, Table 43110-1 provides a means of estimating cubic feet. The facility requirements are based upon the cubic foot space required per man per 30 days. This method utilizes subsistence consumption requirements for shore facilities and provides for two types of storage requirements.

For additional information, see MIL-HKBK 1032/2.

Table 43110-1 TCF Allowances for Refrigerated Warehouse Facilities per Man per Month

Total Cu. Ft. (TCF) Allowances for Category Code 431-10:

Type I Requirement: Allows 4 cubic feet (CF) of perishable subsistence per man per month when fresh milk and bread are received monthly.

Type II Requirement: Allows 3 CF of perishable subsistence per man per month when fresh milk and bread are received at least every other day.

Type	Net Cubic Feet Per Man Per Month	Universal Factor**	TCF Allowances Per Man Per Month*		
			Total	Chill	Freeze
I	4	1.96	7.84	4.12	3.72
II	3	1.96	5.88	4.12	1.76

* All allowances represent average values. If historical data are available that differ from these allowances, such data may be used for requirements planning if fully justified/documented.

** See derivation of "Universal Factor" in appendix P 80X. This factor states, "1.96 TCF are required per cubic foot of material to be stored or 78.4 TCF are required per M/T of material to be stored."

440 GENERAL SUPPLY BUILDING

440-1 DESCRIPTION

This category group consists of supply-oriented covered storage and/or storage support facilities that are assigned to the Supply/Material Department or assigned for storage of operational mount-out stocks. Requirements allowance guidance can be found in the General Supply Planning Guidance under Requirements Determination.

440-2 DETERMINING GENERAL SUPPLY REQUIREMENTS

This section provides information regarding the general methods used to calculate Basic Facilities Requirements (BFRs) for supply facilities.

440-2.1 Definitions.

440-2.1.1 **Cubic vs. Square Feet.** Requirements for supply operations and logistics facilities planning are first found in volume and then in the associated area, as opposed to area alone. This initial measure of volume is more commonly in cubic feet (CF) or measurement tons (MT). A MT is a logistics term that is often convenient to express a palletized or material unit load - and is equal to 40 cubic feet. The second general phase of a logistics requirement calculation is the translation of a given volume into area or square feet of facility required. This second phase is wholly dependant on an assumption of facility and storage system configuration as it interjects an available height or stacking height (SH). This is the height available to the storage function. The accommodation of a given volume requirement can vary with that of different stacking heights. That is, a given volume or cubic foot requirement translates into SF – X with SH – X and translates to SF – Y with SH – Y. This height is either that of an existing or planned building and/or system.

440-2.1.2 BFR Qualification - Existing vs. Planned Facilities.

Supply operations' dependence on available stacking height requires a BFR to carry an assumption of SH that is either based on an existing building and system (status quo), an existing building with system upgrades (modernization) or a new building. It is, therefore, important that the BFR be qualified with the assumptions related to the respective SH (used to translate cubic feet to square feet of facility required).

440-2.2 Calculation Methods. BFRs may be calculated using either the analytical/4-step method or an operational space analysis method as the situation dictates.

440-2.2.1 Analytical or 4-Step Method. There are four steps required for determining storage space requirements by this method. This method is thought to be the preferred and most practical for use in planning up to and including the activity 1391 level or as needed to feed strategic planning.

Step 1 - Total Cubic Feet. Determine the total cubic feet (TCF) required for the CF or MT of material to be stored.

The first factor in the two part equation is determining a cubic feet (CF) or MT required by the user or user group. This cubic measure can be provided by the user (e.g., via records or expert knowledge of business forecast) or determined via a survey of existing operations coupled with an interview aimed at validating observations and forecasting any changes (i.e., survey observes 1 CF, interview relates 20% forecasted increase, requirement is 1.2 CF). A normal desired forecast for requirements is five years.

The second part of this two-part equation translates the raw volumetric measurement of required material into a CF requirement of the accommodating system or facility. This adjustment or translation accounts for the inherent losses in a storage system due to normal operations (various system and operational space losses). A universal factor has been derived and found to be 1.96 for CF and 78.4 for MT. That means that for 1 CF equates to 1.96 TCF required and 1 MT equates to 78.4 TCF required. This universal loss factor, 1.96, adjusts the raw material cubic measurement for various system and operational space losses. For example, 100 CF of raw material required translates to 196 TCF storage space required.

Step 2 – Stacking Height. Determine a stacking height (SH = available stacking height) value. For an existing facility use the current SH value. For a planned facility suggested SH's are shown in Table 440-1.

Table 440-1 Suggested Stacking Heights for Planned Facilities

Type of Storage	Stacking Height (FT)
Open Storage	4 – 10
MTIS, ILO, Outfitting Facilities	4 (without racks) Up to 12 (if racks are planned)
SERVMARTS	4 feet for display gondolas 7 feet for bin shelving
Covered Storage Facilities (other than above)	12
High-Rise Facility (planned available storage height above 12 feet)	Use the planned available storage height.

Step 3 – Net Square Feet. Determine the projected net square feet or NSF requirement by dividing the projected TCF required by the SH value determined in Steps 1 and 2 above.

Step 4 – Gross Square Feet. A NSF to gross square feet (GSF) multiplier of 2.5 or 2.0 should be applied to adjust for aisle, operational, handling and all spaces within the outer portion of the exterior walls defining the notional facility. Use 2.5 with the more common, large aisle operations that normally utilize sit-down, rider counter-balance material handling equipment and are characterized by the related ten to twelve feet maneuvering aisles. Recommend using 2.0 in facilities with more dense, modern systems referred to as very-narrow aisle. These will be characterized by aisles of less than seven feet and often outfitted with vehicle guidance such as electronic wire or mechanical rail. Where this very-narrow aisle system cannot be verified or confirmed, 2.5 should be used.

Alternative GSF Multiplier. Alternatively to the net to gross factors described above, a more accurate SF to GSF multiplier can be calculated, through a notional facility layout that depicts actual floor space required for the rack or storage footprint (i.e., no aisles or collateral areas) and the resulting total facility. The ratio of total space to racked space is the SF per NSF multiplier. For additional assistance please contact the criteria manager.

Additional Support Space. The net to gross factors listed in this step are intended to accommodate some nominal area for material receiving, processing, staging and shipping areas associated with the operation. As such required support areas can vary widely, additional space may

be added to the requirement 'bottom-line' to allow for a more active receipt and shipping operation. This additional space should be supported by and documented from operator input. If such additional processing space is expected to exceed fifteen percent of the total facility, the planner should consider it a separate category code as it may begin to address a transshipment operation that is related to, but additive to, the related storage requirement calculation. In any case it would be a separate and additive calculation to that arrived using the net to gross above. Such transshipment category codes would include 156-10 and 143-55.

440-2.2.2 Operational Space Analysis Method. This method for determining the BFR is prescribed as a more accurate process than that developed using the 4-step method. This Operational Space Analysis Method is expected for any BFR project support beyond the activity 1391 level.

440-2.2.2.1 Total Cubic Feet. The TCF for the operation would be determined as described in step one of the 4-step method above (paragraph 440-2.2.1.1).

440-2.2.2.2 Operational Analysis Mapping. An operational analysis that maps the planned operation within an existing or planned facility should then be used to determine the facility requirements. Using input from the operator, the space analysis should identify and quantify the key operational components such as: administrative, receiving, shipping, storage, aisles. etc. It is expected that the material storage or staging portion of this analysis will include consideration and identification of storage and material handling systems. Note that each of these areas may be comprised of distinguishable components (i.e., storage can be bulk, palletized, rackable and binnable). As actual or planned SH's, aisle spacing, mechanical and miscellaneous spaces are used in this method, no related estimating metrics are required.

440-2.2.2.3 Gross Area Requirement. The sum of the planned areas (i.e., areas comprising the operation) form the gross area requirement - the BFR. It is expected that such an analysis would be supported by narrative and graphical documentation sufficient to convey the planned operational construct that has been coordinated with and approved by the user.

440 - 2.3 **DISCUSSION OF CUBE RELATIONSHIPS.**

440 – 2.3.1 **Material Cube and the Measurement Ton.** The cube of material may be expressed in terms of several units of measure. However, cubic feet and Measurement Tons are the most commonly used in the Navy. A Measurement Ton (M/T) is a volumetric unit of measure defined as 40 cubic feet. An M/T of material can be configured in any shape. It can be visualized, for example, as 40 cubes of material measuring one cubic foot each. The cube of material in bin, rack and bulk storage areas is normally quantified in terms of cubic feet of material or M/Ts of material. The M/T is the preferred unit of measure in the Navy since it is the standard unit of measure used for shipboard cargo.

The following information may prove useful in estimating M/Ts of material in storage when no other data are available. A M/T of material is the appropriate average cube of pallet load of Navy shipment cargo on a standard Navy/DoD 40" x 48" pallet with a load height averaging 36", including pallet. The cube of an average Navy pallet load in storage is typically 0.8 M/Ts or 40" x 48" with a load height averaging 30", including pallet. The maximum pallet load height specified by Military Standard 147 is 54" (including pallet). A pallet load measuring 40" x 48" x 54" high (including pallet) equals 60 cubic feet or 1.5 M/Ts of material. The maximum cargo load size specified by Military Standard 147 on a 40" x 48" pallet (with material overhanging on pallet) is 43" x 52" x 54" high (including pallet). A load measuring 43" x 52" x 30.9" high (including pallet) equals 40 cubic feet or one M/T.

440-2.3.2 **Total Cubic Feet and the Universal Factor.** The Universal Factor provides for the determination of Total Cubic Feet required based on the cubic feet or M/Ts of the material to be stored. The Universal Factor allows 1.96 cubic feet of space for every cubic foot of material that is to be stored, i.e., a ratio factor of 1.96 to 1 applies. This can also be stated as a ratio factor of 78.4 to 40 if both the "1.96" and the "1" are multiplied by 40. The Universal Factor can thus be stated in either one of two ways, i.e., "1.96 TCF are allowed per M/T of material to be stored" or "78.4 TCF are allowed per M/T of material to be stored." The term Universal Factor is used because it applies equally to bin, rack and bulk storage areas. That is, it applies to all TCF in SA Facilities. This is an extremely convenient factor for determining storage space requirements since it means that TCF can be determined, on the basis of M/Ts or cubic feet of material to be stored, without regard to whether bin, rack or bulk facilities are or will be used to satisfy the requirement. Thus, the function of determining the BFR for TCF can be completely separated from the function of facility layout, equipment selection, comparative cost analysis and integrated systems development.

440-2.4 **References.**

440-2.4.1 **NAVSUP Publication 529 – Warehouse Modernization & Layout Guide.** This reference is somewhat dated, but the guidance is

valid regarding the layout planning related to modernization or new construction of warehousing facilities. This remains a significant publication to that end, but should be used in conjunction with some professional logistics engineering input for any purpose beyond initial activity level 1391 preparation.

440-2.4.2 DLAM 4145.12 – Joint Services Manual (JSM) for Storage and Materials Handling. This manual provides detailed guidance on storage and handling of material at DoD installations, by material type. While geared towards operations guidance, this information is critical to some correct planning by providing storage assumptions that impact spatial requirements.

440-2.4.3 UFC 4-442-01N & MIL-HDBK-1032/2. The developing UFC and the MIL HDBK which is its primary text, provide guidance on the design of covered storage facilities. It is of particular interest to planners as it provides information that is relevant to any plans (scope) for modernization or construction, including facility and site layout guidance.

440-3 REGIONAL PLANNING FOR SUPPLY

The application of requirements guidance in a regional planning perspective is meant to identify and exploit opportunities for optimizing facility use. This optimization goal of planning analysis is implied in regionalization (i.e. seeking regional economies of scale) and requires the planner to view the sum of all available assets in their aggregate, wherever practical. It is in this aggregate view of assets that a requirements summary in cubic feet is best translated into an optimal configuration in square feet. In other words, the question of a regional planning exercise is: “What is the most efficient accommodation of my cubic foot requirement within the existing or planned square footage (facilities & systems)?” For additional information on applying this criteria in a regional perspective, contact the criteria manager via e-mail.

441 10 GENERAL PURPOSE WAREHOUSE (SF)

FAC: 4421

BFR Required: Y

44110-1 DESCRIPTION. This code includes general warehouses with the following characteristics: heated or unheated and with/without heavy-duty (overhead crane) capability, sprinkler systems and/or alarm systems. The purpose of related missions is to provide all or some combination of materials staging or storage, handling and processing, receipt and shipping.

44110-2 REQUIREMENT. The general warehouse provides covered space for bulk and in storage, aisle space, space for receiving, packing and crating, office space for direct warehouse supervision (non-administrative) and toilet facilities.

441 11 GENERAL PURPOSE WAREHOUSE, MARINE CORPS DSSC (SF)

FAC: 4421

BFR Required: Y

44111-1 **DESCRIPTION.** This category code includes requirements for Marine Corps ground activities which have been designated by Marine Corps Orders as Direct Support Stock Control activities or which have specialized DSSC functions.

44111-2 **REQUIREMENT.** For new activities, Table 44111-1 may be used for requirements development. The guidance related to 440 series requirements development found in General Supply Planning Guidance under Requirements Determination, is otherwise recommended. If the 10-foot stacking height (SH) used in Table 44111-1 is not applicable, you may reduce the SF proportionate to the increase in SH as a conservative approximation (e.g., if SH is 20 feet vs. 10 feet, 330,000 SF would translate to 165,000 SF). For DSSC mission, include military strength of the base in question plus the military strength of other locally supported units. Non-DSSC activities use only the military strength of the base at which located.

Table 44111-1 Storage Space for DSSC Functions

Installation Military Strength	SF Allowed with SH of 10 feet
Up to 500	7,500
501 to 1,000	14,000
1,001 to 3,000	36,000
3,001 to 5,000	64,000
5,001 to 7,000	96,000
7,001 to 10,000	125,000
10,001 to 15,000	182,000
15,001 to 20,000	216,000
20,001 to 25,000	286,000
25,001 to 30,000	304,400
30,001 to 35,000	333,000

441 12 STORAGE OF AIR OR GROUND ORGANIC UNITS FOR MARINE CORPS (SF)

FAC: 4421

BFR Required: Y

44112-1 **DESCRIPTION.** This category code includes general purpose storage facilities assigned to Marine Corps bases, air installations and Fleet Marine Force (FMF) units for organic requirements to include Division/Wing, Battalion/Group and Company/Squadron storage areas, Special Service storerooms, base shipping and receiving functions and any other organic storage requirements.

441 13 SPECIFIC PURPOSE WAREHOUSE, MARINE CORPS LOGISTICS SUPPORT BASE (SF)

FAC: 4411

BFR Required: Y

44113-1 **DESCRIPTION.** This facility includes general-purpose warehouses designated as storage areas for Marine Corps owned material in support of logistic support base mission as Integrated Material Managers. Also included is the space utilized in support of pre-positioned war reserve stocks.

441 14 SPECIFIC PURPOSE WAREHOUSE, MARINE CORPS SUPPORTED ACTIVITY SUPPLY SYSTEM (SASSY) MANAGEMENT UNIT (SF)

FAC: 4411

BFR Required: Y

44114-1 **DESCRIPTION.** This facility includes general-purpose warehouses designated for support of the Supported Activity Supply System (SASSY) management units to include general and mount out accounts and consolidated issue point assets.

441 20 CONTROLLED HUMIDITY WAREHOUSE (SF)

FAC: 4424

BFR Required: Y

44120-1 **DESCRIPTION.** A Controlled Humidity Warehouse is similar to a General Warehouse (441 10) in every respect except that it is constructed with appropriate vapor barriers and contains humidity control equipment to maintain humidity at desired levels. This warehouse may be a separate building or contiguous with a General Warehouse. See Figure 44120-1 for some examples of requirements that justify a controlled humidity warehouse.

Figure 44120-1. Examples of Justifying Requirements

1. Readiness and immediate issue requirements dictate a low humidity environment for moisture sensitive material.
2. A low humidity environment is required to maintain the condition of material being held in temporary storage while awaiting repair, disposition, preservation or assembly of components.
3. A low humidity environment is required to allow a reduction in reactivation time and/or reactivation cost of moisture sensitive material in storage.

441 30 HAZARDOUS AND FLAMMABLES STOREHOUSE**FAC: 4423****BFR Required: Y**

44130-1 **DESCRIPTION.** A hazardous materials warehouse is required for the storage and handling of materials such as flammable and combustible liquids, acids, oxidizers, poisons, water reactive materials, caustics and organic peroxides. As safe storage of such materials lies in their separation from incompatible materials, a hazardous and flammables storehouse is required as much for adequate material separation as for their storage and handling. Such separations are normally accommodated via separate rooms. Incompatible material separation accommodations will also extend to the planning and design of containment of affluent run-off basins (i.e., in case of sprinkler event). A hazardous materials warehouse will also be equipped with fire protection and ventilation (i.e., harmful or flammable gases) in accordance with National Fire Protection Association (NFPA) standards. Site evaluation of a proposed or existing hazardous materials storehouse should be done in careful consideration to compatibility with adjacent properties, facilities or operations. Due to the compartmentalized layout of such facilities, their proper planning or planning related evaluation is sensitive to a working understanding of proper facility layout and design. Information on warehouse design and sample storage segregation layouts can be obtained from MILHDBK 1032/2, UFC 4-442-01N.

44130-2 STORAGE OF GAS BOTTLE CYLINDERS AND DRUMMED POL.

Storage of bottle gas cylinders and drummed petroleum, oils and lubricants (POL) are not planned for storage in flammables/hazardous warehouses and should be included in shed space, category code 441 35.

441 35 GENERAL STORAGE SHED**FAC: 4422****BFR Required: Y**

44135-1 **DESCRIPTION.** The general shed is a roofed structure without complete side and/or end walls and with or without sprinkler and/or alarm systems. Examples of

material stored in sheds include gas cylinders, vehicles, unfinished lumber and other construction material. Considerations for the applicability of such facilities are based on the relative need for protection from expected area weather conditions.

441 40 UNDERGROUND STORAGE (SF)

FAC: 4421

BFR Required: Y

44140-1 **DESCRIPTION.** Where it is necessary, because of potential sabotage or enemy action to protect supplies either by dispersal or protective construction, instead of programming new protective construction, existing mines may be used. Suitable mines for this purpose include: limestone, marble, quartzite, granite, gold, silver, uranium, lead, zinc and copper.

44140-2 **REQUIREMENT.** Only draft-type entries should be considered. Rooms should not be less than 30 feet wide or less than 12 feet high. Optimum dimensions are 500 feet wide and 18 feet high.

441 70 DISPOSAL SALVAGE SCRAP BUILDING (SF)

FAC: 4421

BFR Required: Y

44170-1 **DESCRIPTION.** This facility is primarily to provide covered space for the receipt, processing, staging and issue of material that has been deemed excess to Navy needs and is awaiting some resale or final disposal. To the extent practical, such operations are expected to use efficient storage practice as with a ready issue material warehouse. Where the warehousing analogy is accurate, the requirements development for this category should follow those of 441 10.

441 71 INTEGRATED LOGISTICS OVERHAUL (ILO) AND OUTFITTING BUILDING (SF)

FAC: 4421

BFR Required: Y

44171-1 **DESCRIPTION.** This facility provides covered supply space used for processing materials offloaded from or assembled for loading aboard ships. It includes space required for receiving, sorting, identifying and processing materials off-loaded as well as processing and assembly of outfitting materials to be loaded aboard fleet units.

44171-2 **REQUIREMENT.** Since the performance of this operation is primarily a function of facility floor space and not stacking height (SH), the determination of requirements is not first one of cubic feet. This operation is not characterized by a significant storage requirement and is not, therefore, dependent on a facility height.

These operations are, however, dependent on a case specific estimate of peak and average operational tempo, processing times, and the related summary of material and operational floor layout requirements. A requirement should be developed using a related space analysis. If an existing operation is present, its floor space can be used as a 'baseline' measure from which to determine requirements through documented interview with the operators. This interview would be designed to forecast operational needs and adjust the baseline accordingly.

441 72 SERVMART (SF)

FAC: 4421

BFR Required: Y

44172-1 **DESCRIPTION.** A SERVMART provides covered supply facilities used for display and sale of supply systems materials for self-service requisitioning by end users. It includes areas used to display items on shelves or gondolas, checkout counters and administrative functions. This category excludes back-up storage areas; requirements for such areas must be based on SH values and are carried under other basic category 441 codes.

44172-2 **REQUIREMENT.** Since the performance of this operation is primarily a function of facility floor space and not stacking height (SH), the determination of requirements is not first one of cubic feet. These operations are, however, dependent on an analysis that accounts for stocked items (i.e. number & type), their stock depth and their retail shelving floor layout. A requirement should be developed using a related space analysis. If an existing operation is present, its floor space can be used as a 'baseline' measure from which to determine requirements through documented interview with the operators. This interview would be designed to forecast operational needs and adjust the baseline accordingly.

441 73 MTIS BUILDING (SF)

FAC: 4421

BFR Required: Y

44173-1 **DESCRIPTION.** A Material Turned Into Store (MTIS) Facility provides covered supply space used for processing materials turned into supply for redistribution or disposal. It includes space used for receipt, screening, identification, assembly and staging for return to storage areas.

44173-2 **REQUIREMENT.** Since the performance of this operation is primarily a function of facility floor space and not stacking height (SH), the determination of requirements is not first one of cubic feet. This operation is not characterized by a significant storage requirement and is not, therefore, dependant on a facility height. These operations are, however, dependent on a case specific estimate of peak and average operational tempo, processing times, and the related summary of material and operational floor layout requirements. A requirement should be developed using a

related space analysis. If an existing operation is present, its floor space can be used as a 'baseline' measure from which to determine requirements through documented interview with the operators. This interview would be designed to forecast operational needs and adjust the baseline accordingly.

451 10 OPEN STORAGE AREA (SY)

FAC: 4521

BFR Required: Y

45110-1 **DESCRIPTION.** This category group consists of non-covered storage areas, paved or otherwise established, for storage of General Supply Materials. Several of the excluded types of functions include miscellaneous materials coded under other basic category codes (e.g., ammunition on open pad coded under 425-10 and open storage areas for non-supply oriented functions coded under 852-35).

45110-2 **REQUIREMENT.** Unless known to be otherwise, a stacking height (SH) of 4 feet should be used in accordance with the Basic Facilities Requirement (BFR) 4-step method described in the requirements section of this guidance. An estimation of material requirements, likely lay-down scenario (i.e., how material is stowed on area) and material handling equipment access is also acceptable as a means of determining square foot (SF) requirements via a space analysis.

451 70 EXTRAORDINARY SUPPORT – DISPOSAL - STORAGE AREA (SY)

FAC: 4521

BFR Required: Y

45170-1 **DESCRIPTION.** This code refers to open areas primarily to provide space for the receipt, processing, staging and issue of material that has been deemed excess to Navy needs and is awaiting some resale or final disposal and whose value is not significantly impacted by uncovered exposure to the environment. This code may also be used for such open yards required for staging or storage of items being held for their scrap value to ongoing missions or systems.

45170-2 **REQUIREMENT.** To the extent practical, such operations are expected to use efficient storage practice as with a ready issue operation. There are no metrics that can serve to guide an allowance for this operational requirement. A SH of 4 feet should be used in accordance with the BFR 4-step method described in the requirements section of this guidance. Otherwise, an estimation of material requirements, likely lay-down scenario (i.e., how material is stowed on area) and material handling equipment access may also be used in a space analysis to determine requirements.