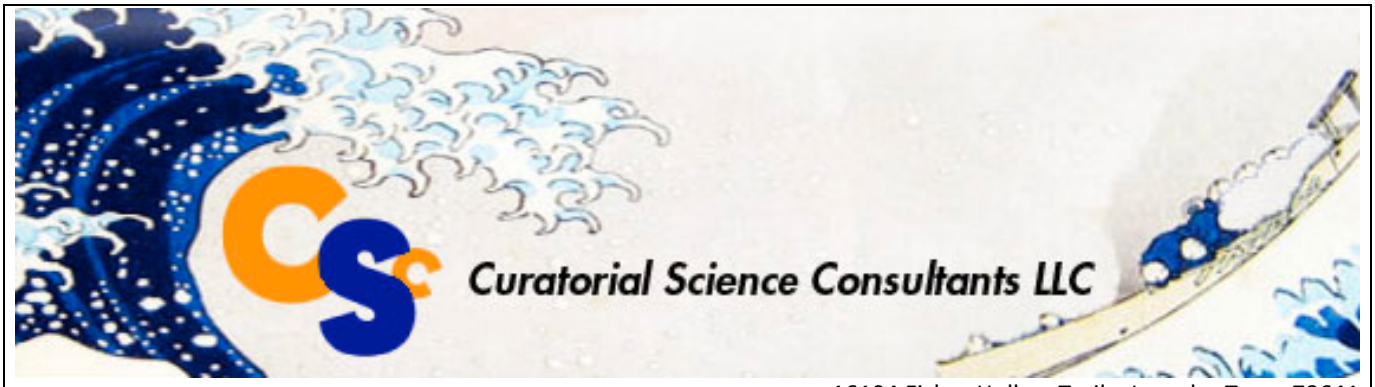

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Facility Storage Sizing Calculations Based On Volumetric Measurements Of Geologic Sample Collections

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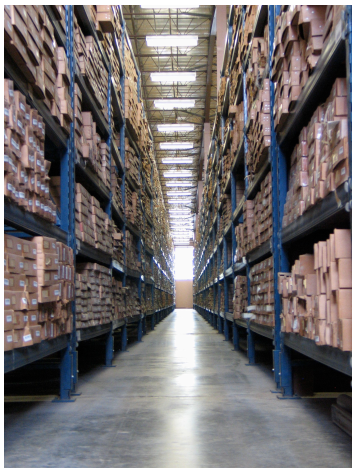
Introduction

A fundamental requirement in sizing a new geologic storage facility is the development of a valid estimate of the existing sample collection that will be transferred into the new facility. This includes not only specifying the required size of the storage system but also the floor area (gross square footage) to install the storage system including circulation area and aisles needed for fork lift/stock picker access.

Pallet racks are a storage system solution that provides the least costly[i] storage of geologic samples. They can store sample boxes amassed on pallets but can also be configured to function as "shelving." Typically geologic sample facilities outfit the racks with preformed wire decking to function as shelves. However, these rack units may of course be configured to accept palletized loads of samples.



Problem Statement

The accurate estimation of required pallet rack capacity and associated facility floor space (area in square feet) should ideally be based on a careful inventory of all samples in a collection – including the form factors of all the constituent sample containers. However in many cases this is not feasible, and the estimation of the required number of pallet rack units and associated floor space must be based on other measurements of the collection.

In a situation where only a volumetric measurement (e.g.; cubic feet) is available, an extrapolation from gross cubic volume to loaded pallet rack units must be calculated.

The calculation should break down the gross volume into estimates for a) the volume of the typical loaded pallet, b) the number of those pallets that can be loaded into a single pallet rack unit, and c) the total rack units required for the existing sample collection to be transferred into the new sample facility.

Basic Calculations

Pallet Dimensions & Cubic Volume

The most basic measurement unit must be determined first - that normally will be the dimension of a loaded pallet. Pallets are available in a wide range of dimensions – there is not a "standard," but it is assumed that the loaded pallets will be stored in a normal pallet rack system. Therefore the depth of the pallet rack will determine the dimensions of the typical pallet used for the calculation.

Please note that if different rack sizes are used then modification to the pallet dimension must be made.

If the depth of our *example* pallet rack system is 3 ft. deep then our "typical" pallet should be 3 ft. wide by 3 ft. deep.

The number of boxed samples that can be loaded on a pallet will depend on the weight of the sample material (density g. /cc^3 – which ranges from≈ 1.9 to 3.4 g. / cc^3) and as well as the form factor of the sample box itself.

However in this *example* it is assumed that from 30 to 48 core boxes could be reasonable stacked on the typical pallet to a height of around 2 ft. high. This configuration yields a volume of 18 cubic feet.

Not only can an estimate of the cubic volume for a typical pallet be made but the example pallet configuration will also allow the estimation of what the range of total sample footage (in the case of core) that can be stored on this pallet.

Consideration must be made for the high level of unknowns in doing this kind of estimation – the total lineal footage of core that fits on a pallet will depend on the core diameter and the dimension of the core box.

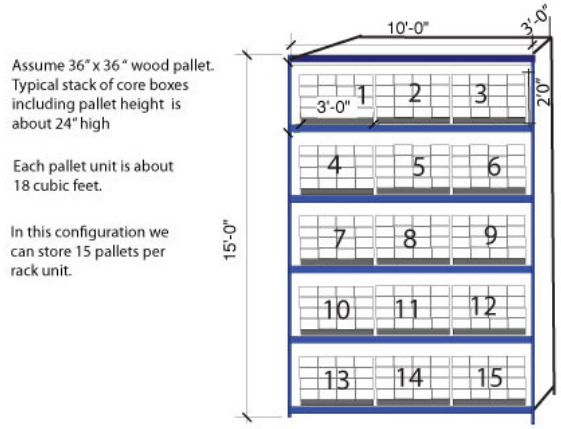
Nevertheless, in this *example* our pallet will be 18 cubic feet in volume, and if it were loaded with core boxes it would store a range from 120 to 360 linear feet of core (average of 240).

Based on this *example* pallet we are then able to extrapolate to the estimated storage needs.

"Example" Rack Unit

For the purposes of this calculation it is assumed that the pallet rack used will be 15 ft. tall, 10 ft. wide, 3 ft. deep, with adjustable crossbeams. A different size pallet rack unit could of course be substituted.

In this example a single rack unit could store 15 of the *example* pallets of sample boxes.



Based the ability to hold 15 pallets we can calculate that the rack unit can store 270 cubic feet of sample (18 cu. Ft. x 15) – note that 270 is the volume just for the samples loaded into the rack – it does not include the gross volume for the rack unit itself. This equates to 3,600 linear feet of core per rack unit – using our *example* pallet.

Volume of Existing Samples

The next data point is the volumetric measurement of samples (this includes

actual sample, containers, dunnage, and void space) in our donor sample facility.

If for example a volume of 150,600 cubic feet were used – that would result in approximately 558 racks full of pallets.

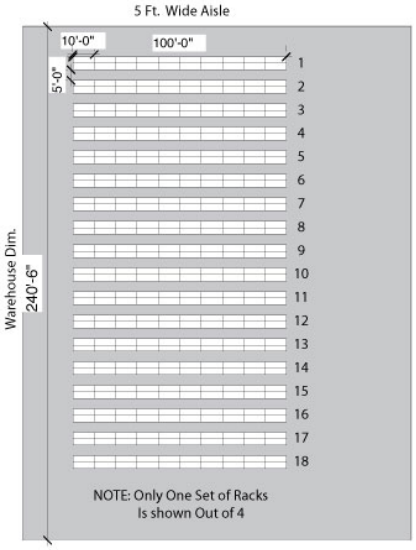
Comparisons of Aisle Area – Pallet vs. Shelf

In this paper we have estimated the number of pallets necessary to store a specific cubic volume of sample material. This could be applicable to diamond drilled core or other forms of geoscience samples. However one critical variable is introduced into the equation when moving from a rack system configured as a shelving system versus a rack system configured to hold full pallets.

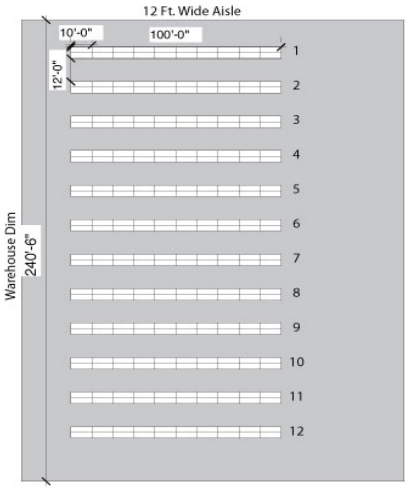
The standard width aisle when using the rack as shelving system is 5 ft. If instead the racks are used as regular pallet racks that nominal aisle width balloons to 12 ft. This is necessary to accommodate front – end access for the forklift.

There are forklift /stock picker systems that can do away with the need to widen the aisles – however these "90°" units are more expensive than standard units. Part of their expense is involved in the fact that they usually need some type of electronic or optical guidance system.

Setting aside the cost issue – if we simply look at the increase in aisle width from the shelf system to the pallet system – we see a 240% increase in aisle width (5 ft. to 12 ft.) That also dictates a reduction in the total number of rack units any sample facility can fit into a warehouse.



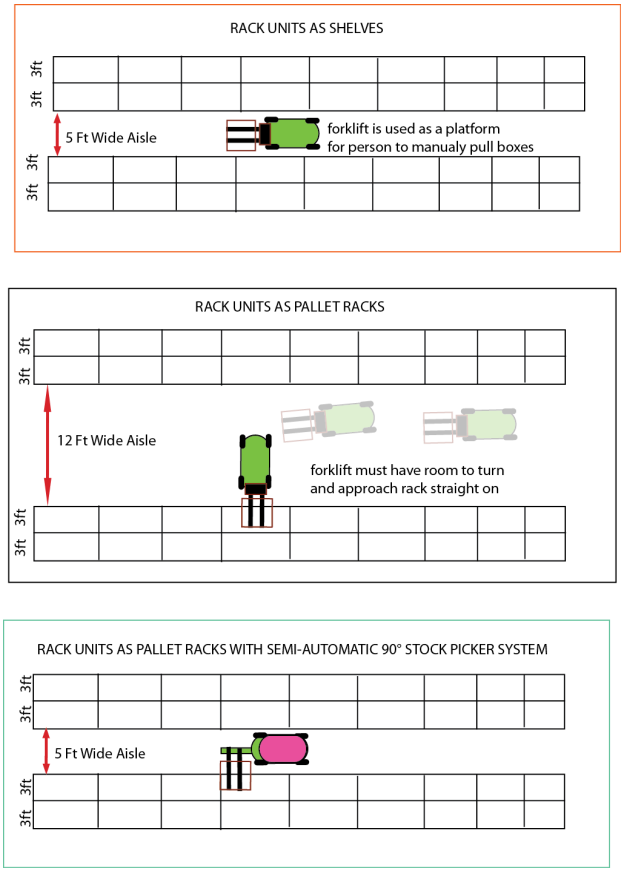
5 ft. Aisle Spacing



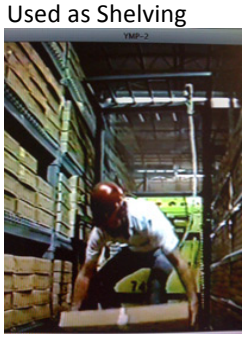
12 ft. Aisle Spacing

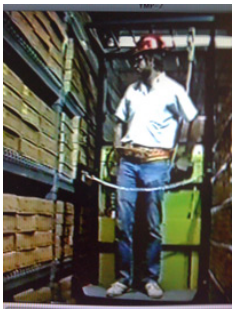
The aisle spacing shown in the above figures illustrate that in this example going from 5 ft. aisles to 12 ft. aisles reduces the total back-to-back rack installations from 18 to 12 (a loss of 60 individual rack units.)

Figure -Three different Forklift/Stock Picker Systems



Examples of Rack Units Used as Shelving





Summary

1. The sizing of a new geologic sample facility should be based upon accurate inventories of all expected sample materials slated to be transferred to the new location. The inventory should include as much detailed information about the samples and containers as possible.
2. Calculation methods to generate a valid estimate of storage requirements may be used in situations where complete inventory data is not available. These may include the extrapolation from volumetric measurements.
   Knowing the size and capacity of the "standard" pallet specified for the facility will allow the calculation of total cubic volumes of samples that can be stored on the number of racks designed for the facility. The rack units may be used as normal pallet racks or as "shelving" units.
3. Establishing the "typical" or "average" loaded pallet size allows the division of the gross cubic volume by the pallet cubic volume – this results in an estimate of the storage needs.
4. Precise engineering calculations must be performed based on maximum density (weight) of the samples to be stored. The calculations must determine the specifications for the rack unit load capacity as well as concrete slab load capacity.
5. Adequate precautions must be taken when extrapolating from volumetric to stored samples. There can be great variations in rack size, pallet size, pallet loading, etc., etc.
6. Differences in required warehouse floor space (square footage) for Rack systems used as pallet racks vs., configured, as shelf systems must be

addressed in the calculation. Generally rack units used as shelves use 240% less floor space than rack units used as pallet racks. However, if more costly semi-automated forklift/stock picker systems are used there may be no loss of floor space.

7. A comparison of costs for deployment of a semi-automatic (90°) forklift system vs. "wasted" extra aisle floor space should be performed to arrive at the least costly and most efficient solution.

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[i] In this instance cost includes maximization of storage space, not simply a less costly shelving solution.