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A Curatorial Science Consultants White paper

Facility Storage Sizing Principles For Geologic Diamond Drilled Core Collections

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Introduction

Estimation of storage space for geologic diamond drilled core should be based primarily upon two elements. The shelving or racking system to be used is the fundamental determination of what containers can be efficiently stored. Secondly the dimensions of the most common containers in the collection need to be determined and calculations performed to arrive at the capacity of a single rack unit.

The form factor of core boxes, especially for collections dating back to previous decades, can vary wildly in dimension, and in material. Storage of core in wooden boxes was common prior to modern corrugated cardboard units. Additionally many collections contain non-uniform containers ranging from fruit crates to burlap sacks.

Problem Statement

The primary issue addressed by this whitepaper is "How can we arrive at a realistic estimate for needed storage capacity for any given collection of geologic core?"

An underlying principle that drives the storage of core is the assumption that these materials will be moved in and out of storage for scientific examination and for the removal of specimens.

That "material handling" cycle dictates that the geologic collection must be stored (and inventoried) to enable the efficient access, transfer and layout of core boxes in the facility for examination.

This demands that even a single box can be pulled from storage in a timely manner.

Therefore the collection should be boxed (or in many cases re-boxed) in a limited range of containers that integrate in a modular fashion into the rack storage system.

An example illustrating the benefits of using a limited set of uniformly sized core boxes is the Canadian example. The Energy Resources Conservation Board Core Research Centre in Calgary, Alberta for years has required that core being submitted to the facility be stored in a very limited set of box sizes. The mandated box sizes have a commonality in that they all integrate dimensionally into the rack system being used.

The necessity for upgrading a complete collection into a uniform set of boxes is a major cost, but a necessary cost if the collection is to yield its highest scientific and technical value.

Basic Calculations

Rack Systems

Rack systems are a compromise solution that provides a less costly "shelving" system than a set of actual shelves. The rack systems used in major geologic core facilities are actually more properly termed "pallet racking" and are actually primarily designed to store palletized materials. Geologic core facilities outfit the racks with performed wire decking to function as shelves.

The use of a rack system as a core box shelving system allows the least expensive storage option while providing for efficient accessibility.

Figure 1. Rack System as Shelving

Core Box Sizes

Waxed core boxes are available for all industry standard core diameters – however the set of box sizes should be limited to as few as possible. This is to achieve the most efficient storage system.

Table 1. Common Core Diameters

Designation	Diameter inches
A-	1.06"
B-	1.44"
N-	3.35"
H-	2.5"
P-	3.35
4 inch	4.00"

The assumption is that the majority of cores in a collection will fall within the diameter range from 2.5 to 4.0 inches. That premise allows the calculation of minimum and maximum (linear feet of core) loading per box, per stack, per rack shelve, and per rack unit.

Core Capacity Calculations – in Linear Footage

Assume the standard rack unit is sized 15 ft. tall, 9 ft. wide and 3 ft. deep. This of course is only one of many configurations available. Each rack is assembled with a set of adjustable cross beams and associated wire decks – the decks form the "shelf" surface. Taking some of the most common core box sizes and "loading" the "shelves," allows an estimate of total lineal footage of core that can be stored on a rack shelf and entire rack unit.

The following table provides the loading and lineal footage capacity for three common box sizes.

Table 2. Rack Capacity in Linear Feet of Core

Core Size	Box Dimensions		
	Length	Width	Height
(A) 2.5 In Dia.	30 in	13 in	3 in
(B) 4.0 In Dia. Whole	24 in	8.25 in	4 in
(C) 4 in Dia. split core[1]	36 in	14 in	3.5 in

Box Footage	Boxes Per Shelf	No Boxes Per Rack	Linear Footage Core Capacity per Rack Unit
(A) 10 Ft	49	294	2,940
(B) 4 Ft	60	360	1,440
(C) 9 Ft	36	216	1,944

[1] It is common to split 4-inch diameter core into 1/3 and 2/3 portions, the 1/3 provides an "archival" split, the 2/3 portion the working portion available for specimen removal.

An Average of Different Capacities

Calculation of the average rack capacity derived from the most common planned core box types appears to allow a reasonable estimate for an entire facility's linear core capacity.

In the current example from Table 2., the average is 2,108 linear feet of core storage capacity per rack unit (in this example 15 ft. High x 9 ft. wide x 3 ft. deep.)

The average is then multiplied by the total number of rack units planned for the facility.

If the planned facility had 100 rack units then the capacity would be 210, 800 feet of core capacity. A 1,000-rack unit facility would have 2,108,000 feet of core capacity, and so on.

Maximum efficiency vs. Reality

It is important to understand that real world conditions will necessitate a trade off between the most efficiently loaded storage system and the actual conditions faced by the core facility. It is possible that the limitations on total weight capacity for a core box will not allow taking complete advantage of the depth of the shelf. For example the weight of 4 inch diameter core may limit the length of the box to something less than the most efficient 36 inch long box – which would best fit on a 36 inch deep shelf.

Also the actual capacity of any rack system may vary depending on a variety of factors. Fire, seismic, or radiological or chemical sample constituents can severely limit the density of core boxes that can be stored in a particular storage system.

Therefore it appears to be logical to modify the *Average Capacity* Calculation plus or minus 15 percent simply to account for presently unknown contingencies.

Extrapolation to the Entire Facility

Application of the *Average Capacity* Calculation for an entire geologic core facility is simple multiplication in order to arrive at an estimated total core (lineal footage) capacity. However another very important piece of data is the building area calculation (square footage) for the planned facility.

In this case the footprint of the rack system and the box retrieval system (fork lift truck, automatic retrieval system, order picker etc.) determines the floor area.

The footprint of the rack units is straight forward - length x width. For example a typical rack might measure 3 foot wide by 9 foot long, however any uprights that escape the nominal size must also be included in the calculation.

A critical sizing element is the width of aisles where the fork lift/ order picker operates allowing warehouse personnel to pull core boxes. Current practice based on commonly available lift trucks is to have a minimum 5-foot wide aisle between rack units. That results in each rack unit and aisle pair to typically be a minimum of eight feet (rack; 3 ft., aisle 5 ft.) Additionally, the area at the end of a rack unit (usually placed in back to back pairs) must be sufficient for the lift truck to circulate around.

Summary

1. Cost benefits dictate configuring standard rack systems as a shelving system.

2. The fewer different core box sizes stored by a facility the better for efficiency.

3. Calculate the Average storage Capacity of a single rack unit based upon the most predominate 3 or 4 box sizes in the collection (existing or proposed for reboxing.)

4. Modify that *Average Capacity per Rack Unit* by including a range of 15% plus or minus to account for unknowns.

5. Multiply the *Average Capacity per Rack Unit* by the total rack units planned for the facility.

6. Ensure adequate floor area (square footage) is included for all rack units, aisles, end of unit areas, and warehouse ingress, egress, and access to adjacent areas.

Disclaimer

The design of a core storage facility is an engineering exercise that requires a high level of expertise. Especially the calculation of storage rack weight capacities, and overall floor slab capacities are critical. This whitepaper is provided only to establish the logic beneath an estimation method to arrive at gross estimates for the core footage capacity of a storage system.