SCOTTMADDEN
Management Consultants

✓ Materials Management within U.S. Nuclear Generation Plants

Introduction

A recent study of materials management performance at North American generation plants provides an opportunity to take a critical look at this function within the nuclear generation industry.[1] The results show that materials management within the industry is exceptional in many ways. This article explores several of the unique features of the industry and highlights opportunities for improvement in materials management going forward.

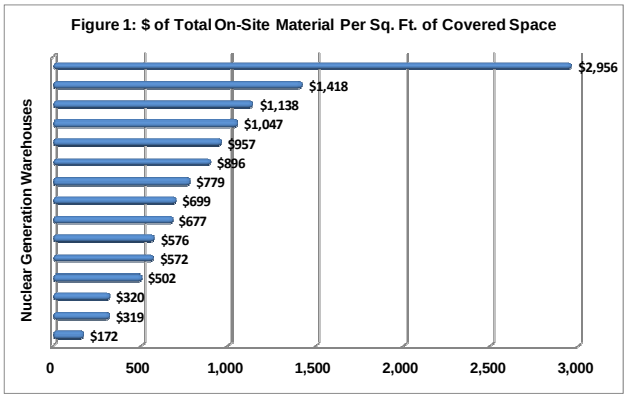
John Sequeira, Ph.D.
Partner
2626 Glenwood Avenue, Suite 480
Raleigh, NC 27608
919.781.4191
johnseq@scottmadden.com

Steve Gilbert
Senior Associate
3495 Piedmont Road, Suite 805
Atlanta, GA 30305
404.814.0020
stevegilbert@scottmadden.com

[1] "2007 Utility Materials Management Benchmarks – Nuclear Generation," (Utility Materials Management Benchmarking Consortium, December 2007). The data is based upon detailed reports for 15 nuclear sites having a total of 30 reactors.

Warehouse Size and Density

The size of covered warehouse storage space in North American nuclear plants varies greatly from plant to plant, ranging from a low of 14,400 square feet to a high of 210,000 square feet, with a median size of 79,000 square feet. In many cases, the design and physical layout of the warehouse is not conducive to optimal inventory flow. Uncovered storage space, or "laydown" yards, also varies greatly in size, ranging from as little as 15,000 square feet to as much as 480,000 square feet. More telling is storage density, which is measured in terms of the dollar value of inventory per square foot of covered space. As shown in Figure 1, inventory storage density varies from as little as $172 per square foot to as much as $2,956 per square foot. Some warehouses have room to spare, while others are densely packed.



Material Handling Equipment

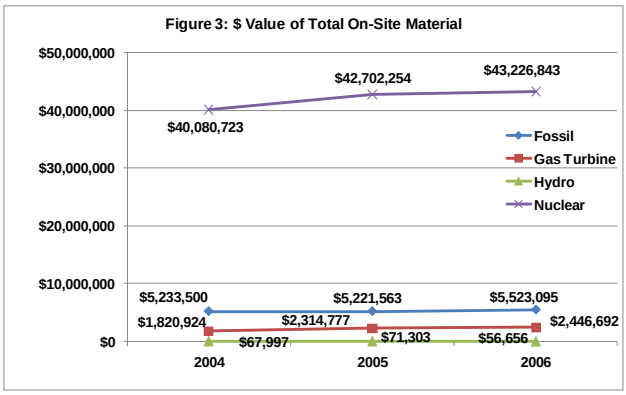
The equipment used to handle material within nuclear generation warehouses is similar to that found in most commercial distribution centers. Average equipment numbers per plant are highlighted in Figure 2. Not surprisingly, the most common equipment consists of riding lift trucks followed by non-motorized lift equipment. No automated carousels or high-speed sorting equipment were found at any of the surveyed plants. Pick-up trucks and other transportation equipment are not included in these numbers. The ratio of equipment to inventory varies from a low of one unit per $150,000 in inventory to one unit per $470,000 in inventory. It appears that some plants have three times more equipment per dollar of inventory than others.

Figure 2: Warehouse Equipment at North American Nuclear Plants

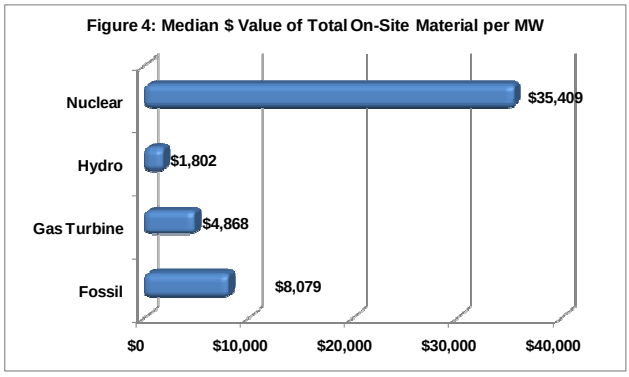
Material Handling Equipment Metrics	Minimum	Mean	Median	Maximum
Non-Motorized Lift Equipment	2	5	4	8
Motorized Riding Lift Trucks	3	8	7	17
Motorized Standing Lift Trucks	0	3	2	12
Other Moving Lift Equipment	0	1	0	8
Moving Equipment Units per 1,000 Sq Ft. of Storage Space	0.07	0.24	0.17	1.04
Moving Equipment Units per $1,000,000 in Inventory Value	0.15	0.28	0.27	0.47
Moving Equipment per Material Management FTE	0.50	0.90	0.90	1.40

Inventory Levels and Growth

Inventory maintained at generation plants consists of both capital equipment and material held for maintenance, repairs, and operations (i.e., MRO inventory).[2] As shown in Figure 3, inventory levels held at nuclear plants are nearly eight times higher than those found at fossil plants. Some difference is to be expected given the relative size of the plants involved. However, when the data are adjusted for generation volume, the results still show that nuclear plants have more than four times the inventory of fossil plants per MW generated (see Figure 4).



Not only are inventory levels at nuclear plants much higher than those at fossil plants, they are growing 40% faster (3.8% per year versus 2.7%). Since these observations are based on warehouse-level reporting, the increases are not being driven by new plants but by expansions, upgrades, and new inventory cost escalation. Given the need to continually manage operating costs, these levels and growth rates are of some concern and merit further inquiry.



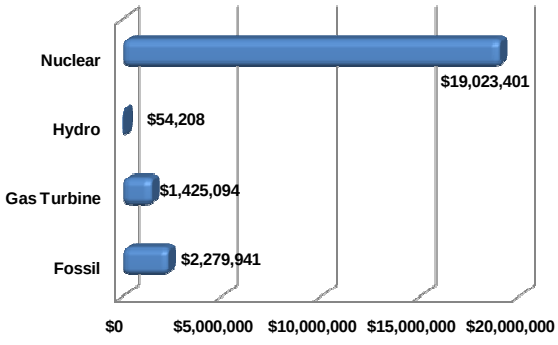
Inventory Activity

Inventory turnover rates at North American nuclear plants are low, ranging from 0.19 to 0.91 per year. On any given day, nuclear plant warehouses hold an average of 995 days of inventory—or nearly three years of inventory at current usage rates. The largest contributor to the high inventory levels appears to be an exceptionally high volume of slow/non-moving inventory. Figure 5 shows the median dollar value of inventory with no issues over the past five years at all generation plants. Once again, nuclear generation stands out. The average nuclear plant holds nearly $20 million in slow/non-moving inventory.

[2] NOTE: Inventory as used in this article refers to both non-costed capitalized items plus FERC 154 inventory. The combined total is referred to as "Total On-Site Inventory." This is believed to be the best indicator of actual material held on site for future use.

Much of this slow-moving inventory is believed to be critical spares, which have been on site since the plants were originally commissioned. These are generally long-lead-time items that may be unique to the plant and that already have been capitalized and depreciated. It often makes sense to keep these items, even though the probability of their ever being used is low. Since no industry standard definition for "critical spares" exists today, the study was unable to control for this factor. The value of critical spares and their impact on inventory turnover remains a subject for future study.

Figure 5: Inventory with No Issues over Past 5 Years



How Much Is Enough?

Any plant manager worth his or her salt would rather err on the side of having too much inventory than take a chance on having too little. But are we overdoing it? The study provides some clues but cannot definitively answer this question. The correlation between "Plant Capacity %" and "Days of Inventory" is weakly positive at +0.27. This implies that higher performing plants tend to hold more inventory on hand. On the other hand, the correlation between "Plant Capacity %" and "Over Max Inventory" is slightly negative, but inconclusive. Unfortunately, without a common definition of "critical spares" it is impossible to answer the question of whether we have too much inventory on hand. That remains the task for the plant material analyst.

Warehouse Organization and Staffing

The study results provide interesting insights regarding warehouse organization and staffing. The reported number of material management personnel at nuclear generation plant warehouses expressed in full-time equivalents (FTEs) is displayed in Figure 6. The total number of personnel working in nuclear plant warehouses ranges from a low of 10 to a high of 93. As expected, most personnel are material handlers, which go by different names at different plants (e.g., storekeepers, material handlers, materialmen, etc.). There are also a small number of tool room, quality control, and administrative support personnel. Interestingly, the ratio of management to staff varies significantly between plants, ranging from a low of 2.3 to a high of 15.5. There also appears to be little relationship between the number of personnel and the size of the warehouse or the value of inventory being stored. The square feet of space managed per FTE ranges from a low of only 900 square feet to a high of 17,500 square feet, while the dollar value of inventory managed per FTE ranges from a low of $1.37M to a high of $6.88M. This indicates that space and inventory have less to do with warehouse staffing than management's approach to staffing and supervision.

Figure 6: Nuclear Generation Warehouse Organization and Staffing

Warehouse Organization and Staffing Metrics	Minimum	Mean	Median	Maximum
Material Management FTEs by Position				
• Managers, Supervisors, Team Leaders, etc.	1	3	3	6
• Material Analysts, Coordinators, etc.	0	2	1	15
• Storekeepers, Material Handlers, Materialmen, etc.	0	14	10	63
• Tool Room Personnel	0	2	0	10
• Quality Control Personnel	0	<1	0	6
• Administrative Support	0	1	0	5
TOTAL MATERIALS MANAGEMENT FTES3	10	21	15	93
Ratio of Management to Staff Personnel	2.3	6.3	4.5	15.5
$ Value of Inventory per FTE ($M)	$1.37	$3.28	$3.00	$6.88
Sq. Ft of Covered Storage Space per FTE	900	5,720	3,856	17,500

Employee Workload and Productivity

The study data also allow us to examine warehouse transaction volumes and employee productivity. As in most warehouses, the workforce is principally involved in receiving material, storing it in the warehouse, then picking and issuing this material as needed. Returns of unused material to the warehouse and/or returns of material from the warehouse to the vendor must also be handled. The total volume of all these transactions is influenced by: (a) the size and complexity of the plant, (b) the volume of capital or maintenance work underway, (c) the accuracy of planned work orders, and (d) the degree to which the items received or issued are aggregated into larger orders (i.e., fewer transactions). According to the data, the median number of all transactions handled (receiving, issuing, and returns) was 24,428 per year. These transactions had a median U.S. dollar value of $45M and involved 3,729,647 individual items.

[3] Note: The totals presented in this table do not represent the total of the numbers in the column but were calculated as independent data ranges from individual warehouse data.

Figure 7: Nuclear Warehouse Employee Productivity

Warehouse Employee Productivity Metrics	Minimum	Mean	Median	Maximum
Number of SKUs Managed per FTE	1,024	3,972	2,901	7,024
Number of Transactions Managed per FTE:				
• Receiving/Putaway Transactions per FTE	152	484	451	758
• Picking/Issuing Transactions per FTE	482	1,079	872	2,323
• Return Processing Transactions per FTE	75	195	130	762
• TOTAL Transactions per FTE4	823	1,758	1,460	3,764

As shown in Figure 7, the volume of transactions handled per employee per year varies significantly from a low of 823 at one plant to a high of 3,764 at another. This invites two observations. The first is that the number of transactions handled averages only 2.2 per day—a far cry from the hundreds of transactions handled per day by workers in commercial distribution centers. The second is that warehouse personnel at one site handled more than four times as many transactions as did those at another. Factors which might account for this disparity include: (a) the size and layout of the warehouse, (b) the number of different parts (SKUs) held in inventory, and (c) the availability and type of material handling equipment. However, once again, it appears that management's approach to warehouse organization and staffing must play a significant role in explaining these disparities.

Inventory Accuracy

Items held in inventory are periodically counted to ensure that what is "in the books" reflects what is "on the shelf." Count accuracy is typically measured in terms of both quantities and dollar values. Dollar-count accuracy at nuclear plants ranges from a low of 82% correct to a high of 100% correct. Item-count accuracy is lower and ranges from 76% to 99%. At the low end, these accuracy rates are considerably lower than what one would expect to find at a large commercial distribution center where benchmarks for item-count accuracy range from a low of 98% to a high of 99.98%. Considering the large volume of items which are not touched (see Figure 5), and the low number of transactions handled (see Figure 7), it is surprising that accuracy rates are not higher.

[4] Note: The totals presented in this table do not represent the total of the numbers in the column but were calculated as independent data ranges from individual warehouse data.

Achieving "Best-In-Class" Status

In many ways, the survey results invite more questions than they answer. However, they do paint a picture of what best-in-class materials management might look like within today's nuclear generation warehouses. Figure 8 presents several "Best Quartile" numbers from the survey.

Figure 8: Best-In-Class Performance

Key Performance Indicators	Best-In-Class
Total $ Value of Material On Site per MW Generated	$28,439 or less
Material Handling Equipment Units per $1M of Inventory	0.23 or less
Turnover Rate in Total On-Site Material	0.48 or higher
Days Inventory in Total On-Site Material	761 days or less
$ Value of Total On-site Material per FTE	$3,809,070 or more
Total Number of Annual Transactions Managed per FTE	2,124 or more
% Physical Count Accuracy – Based on Items	97% or higher
% Physical Count Accuracy – Based on $ Value	99% or higher

As with all benchmarks, these targets simply point the way. There will always be reasons why a particular plant cannot or should not achieve a particular performance level. But the survey data show an exceptionally wide variation in performance levels across the industry and invite us to question how some plants are able to achieve exceptional performance levels while others do not. Having a direction to point to can be a good thing, and this study provides us with plenty of pointers.