



Appendix J

ProTeam Articles

The articles included in this appendix are all variations on a theme: How can we become more effective and efficient at the task of cleaning? We start with David J. Frank, who reintroduces us to the father of scientific management, Frederic Taylor, and explains that Taylor's ideas are still relevant today. Then we hear from Jim Harris Sr., who declares that now is the time for the cleaning business to join the computer revolution; Jennifer C. Jones gives a detailed look at the latest activities at the Carpet and Rug Institute (CRI) and makes a very effective case for purchasing only those vacuums that have achieved CRI certification. Chris Murray presents a very compelling case to consider worker ergonomics when purchasing equipment if you want to keep your

people happy and increase productivity. ProTeam, president Larry Shideler contributes two articles: one on vacuum filtration and another on the "Science of Suction" (in vacuums). John Walker explores the subject of team cleaning, which has boosted productivity in a number of operations. Finally, Robert Woellner dispels some old myths regarding vacuum cleaners and presents the results of a recent controlled study of vacuums and soil removal.

All of these articles are appearing through the generosity of Larry Shideler, president of ProTeam Inc. A sincere note of thanks to all those at ProTeam who assisted with this project.

Classic Management Science Drives New Clean Gains

By ProTeam

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

The quest for discovering how work can be best performed is nothing new. As the Industrial Revolution spawned large factories and assembly lines, prominent engineers and others began to analyze human behavior at work, in the interest of improving efficiency.

By the late 1800s, people like Frederic Taylor were analyzing tasks and human elements as if they were parts of a complex machine that could be fine-tuned for top performance. These early seeds of Scientific Management set the stage for continuing research aimed at increasing productivity. One remaining comical image of this era is that of the uptight industrial engineer—stopwatch, pen and clipboard in hand—huddling over workers and meticulously recording their every movement, to be incorporated into time and motion studies.

Yet, in truth, the core concepts of early scientific management were on the right track. Early proponents laid the groundwork for analytical approaches to workloading. Today, organizing work flows, information flows, and how people interact to fulfill job specifications are all proper domains of effective professional management. In particular, the model of breaking work into smaller pieces to be defined and performed by a team of “specialists” is not only current and useful, but also state-of-the-art in the science of cleaning. We inherited the principles of scientific management and have shaped them to meet human needs as well as production needs.

Cleaning by the Numbers

Modern managers in the contract cleaning industry have accomplished a revolution of their own by switching from traditional zone cleaning to more scientifically based specialized or team cleaning. Typical results show that zone cleaning is considerably less efficient than specialized cleaning methods. Specialists cover much greater floor space in the same period of time—and with higher overall quality of cleaning.

One of the main reasons for this high performance is that specialists know exactly what is expected of them since jobs and tasks are carefully delineated and training is systematized. Work patterns of workers are precisely routed for optimum efficiency. Guesswork and overlap are practically eliminated. The team of specialists operates like a well-oiled machine—in a sense, like the ideal model envisioned in early scientific management concepts. Also, breaking of tasks into definable, discrete

units facilitates measurement, analysis, and improvements using computer software.

Multiply the Gains with Software

Just as specialized cleaning streamlines the flow of work, new computer software streamlines other technical aspects. As labor time standards for methods of cleaning become standardized, this information can be input into software for comparisons. Growing data is available on labor times for both zone cleaning and team or specialist cleaning methods (one source: ISSA—International Sanitary Supply Association 1-800-225-4772). Cost and labor analysis software is invaluable since it allows apples-to-apples comparisons between different methods of cleaning, and quantifies labor costs for different scenarios.

For example, one hospital determined that vacuuming specialists averaged 6,000 to 10,000 sq. ft. per hour using backpack vacuums and team cleaning, compared to 2,500–3,000 sq. ft. per hour using older zone methods and floor-based equipment. Workers performing light duty tasks (emptying waste containers and dusting) averaged 4,000–6,000 sq. ft. per hour using a team specialist approach versus 2,500–3,000 sq. ft. per hour with older techniques.

This kind of data can be recorded in interactive software and be used to extrapolate costs, generate bids, and demonstrate the cost-effectiveness of selected methods to customers.

Another computer advantage: Using software to project costs allows “experimentation” without capital expenditure. According to a Houston, TX–based distributor of janitorial supplies: “We use a computer program to compare the customer’s existing program with the team cleaning approach we recommend. Initially, we take a survey of the building, and input the facility parameters—square footage, number of hours per shift, labor hourly rate, employees per shift, etc. Then we input the numbers required for team cleaning, show the reduction in labor and equipment, and generate a computer print out.”

The results, he points out, can be dramatic. For example, in a 250,000 square foot office building, with an hourly rate of \$5.40, if you increase the vacuum production *alone* from 6,000 square feet an hour to 10,000 square feet, the annual saving is \$21,600 (based on a 20 day month). As he states, “When you show a customer that, you can be sure you have his attention.”

High-Tech Bidding for Business

New third-party computer programs are invaluable to contractors for separating accurate estimates and producing convincing graphic presentations for the bidding process.

Some new software packages supply formatted templates, so the contractor simply plugs in numbers and basic information such as amount and types of floor to be cleaned, by what method, using what level of worker, and with what frequency. The contractor also fills in vacation time, projected sick pay, and other and equipment cost factors at increasing levels of detail, as needed to bid on a particular job. The program not only performs all calculations and itemizes results, produces easy-to-read charts and graphs—with suggestions on how to use in bid presentations.

Best of all, template-based software can be revised at a touch of the keyboard—literally. The user can vary the input to display “what-if” scenarios that satisfy a different set of assumptions. This permits instant re-bidding when the customer suddenly changes the specs or when the contractor wants to show the prospect exactly how much can be saved (in time and in dollars) by cleaning the glass areas three times a week instead of five, or by using a backpack vacuum with a 14-inch floor tool rather than an 18-inch dust mop for cleaning vinyl flooring.

Similarly, templates and calculations can be rolled over for new jobs to produce estimates using variations of the prior calculations. In other words, the contractor is building his or her own database from every estimate to enable ever more precise estimates covering an ever wider choice of bid specifications, all available at a keystroke. We now have at our disposal hassle-free high-tech computer tools that help contractors organize work, manage information, streamline bidding, and refine the human/equipment/production/place equations to suit the needs and budgets of customers.

Seeing Is Believing and Controlling

New software packages often include a module for work scheduling. This fill-in-the-blanks onscreen approach enables managers to schedule work crews and routes, to generate printed work tickets for workers, and to monitor the status of job assignments. Of course, this work scheduling module connects directly to others for comprehensive billing, payroll and other key business functions. With the calendar screen in some programs, contractors can view scheduled tasks for an entire month—allowing effective planning and providing a means to show customers the comprehensive scope of the cleaning plan.

Modern scientific management means using computer capability to manage major projects, determine

work schedules, track progress and costs, produce payroll and billing—all while improving accuracy and saving time. Managers can keep on top of the work, overseeing the business for maximum efficiency and productivity.

Besides the gains made possible by computer software applications, the new scientific approach as reflected in specialized cleaning adds hard-core gains on the floor, in daily actions.

Divide and Conquer the Work

The concept of creating a team of cleaning specialists gains power by harnessing individual focus and dedication. For example, cleaning tasks are organized into categories, typically four areas with a specialist for each: light duty, vacuuming, rest rooms, and utility. Each cleaning specialist is trained in the preferred procedures, products, and the proper equipment to be used to get the desired results. This automatically builds in consistency of method, uniformity and compatibility of cleaning products, and recommended work time frames based on known benchmarks.

Workers who specialize simply do *more* work faster. Workers learn the best and fastest ways to clean; they use the most efficient equipment. Efficiencies are gained individually and compounded by repeating the module of cleaning specialists throughout a given facility.

Modern software packages can help contractors demonstrate the savings inherent in using specialists for cleaning, and document their ability to tackle additional tasks within the same working budget due to the efficiencies gained using scientific management principles.

Conclusion

Scientific management has truly come of age in the cleaning industry as the principles of breaking work into bite-size pieces meets the computer’s ability to process byte-size databases into usable decision-making information. It’s transforming how cleaning is done and, in most instances, lowering its overall cost significantly. Make no mistake about the dimensions of the revolution: Contractors who remain aloof or resistive to the implications and applications of modern scientific management will dissolve in the heat of competition.

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Custodial Management in the Information Age

With the advent of bar codes, handheld readers, and appropriate software, modern technology has finally reached the custodial department. Why computerize? Read on.

By Jim Harris Sr., CBSE

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

Delivering high-quality services, increasing productivity, and managing resources cost-efficiently are issues faced by all businesses. The challenge to custodial service providers is keeping up with job activity and inventory data retrieval, analysis, and application. As with many challenges today, the solution can be found in technology. Electronic data collection and tracking systems using bar code technology make the gathering and sound use of information easier.

Bar coding was introduced in the 1970s, and today it is an important part of many business operations. The bars, which vary in width and spacing, represent the binary digits 0 and 1. A string of digits functions as a unit and assigns a unique identification code to an item.

Though still in its infancy in the custodial management process, a bar coding system can offer a level of data integrity previously unobtainable with manual systems. Many feel this will become the new industry-standard technology for data management.

Bar-code labels are placed in areas to be monitored such as offices, classrooms, patient rooms, hotel rooms, elevators, or even storerooms; or on objects to be monitored, from backpack vacuums to vehicles. Scanning the label with a hand-held bar code reader activates the system. Readers are programmed and can be reprogrammed to prompt for answers to many specific questions each time a bar code is scanned.

For example, to start a room inspection, a manager swipes a bar code sticker attached to a door jamb. The bar code reader asks if trash was emptied, dusting completed, vacuuming done, furniture rearranged, etc. Yes or no answers are entered. By also assigning numeric values to cleanliness, bar code readers enable measuring levels of clean, in effect not only asking, "Was the work done?" but "How well was it done?" A detailed inspection may take less than a minute and results for that room remain in the unit for processing.

Workers who carry bar code readers can scan a separate bar code to inform the system of their progress at a specific time during the shift, increasing accountability and scheduling precision. In a team cleaning scenario, the vacuuming specialist can also act as inspector for the light duty specialist preceding him/her.

The information collected on the portable readers is easily transferred to and from a personal computer

through a simple modem connection to a telephone line, or via mobile phone.

Once data is uploaded, proprietary software can delineate results by supervisor, employee, building, floor, or other variables, providing meaningful analysis and reports of worker performance, building cleanliness, or other important benchmarks.

It can also help catch small problems before they become big. For example, if the data indicates a worker is moving too slowly in some areas and running out of time before completing his entire work circuit, managers can pinpoint where the slowdown occurs, how the worker compares to others doing the same or similar jobs, and provide additional training as and where needed.

Ultimately, the process can provide a full audit trail of essential information including the time and date of input, providing a high level of detailed reporting for analysis. Integrated software prints information as pie charts, bar graphs, spreadsheets or customized formats.

Bar Code System Advantages for Custodial Performance Management

- Measuring, tracking and improving quality of custodial services;
- Creating accountability;
- Measuring, reassessing and maximizing staff productivity; and
- Improving staff performance through better management of their skills and time.

Bar-coding systems customized to your situation and goals can be effective tools to address specific, localized needs. They can also be integrated into organization-wide information systems to relay data throughout by e-mail or intranet. Uses include facilities management, construction, plant operations, grounds, and security.

High-speed bar code processing units come with versatile software programs. Here are some examples:

Computer-aided cleaning management. An overall program that keeps track of an entire operation, including personnel, assets and resources is the computer-aided cleaning management system. State-of-the-art offerings, such as Innovise Software's recently updated Comtrac 3, have internet and intranet capabilities and provide a comprehensive range of performance reports to help identify consistent area of weakness and

strength. Capabilities include fast mobile phone messaging and data transfer.

The system enables the use of bar codes to speed the collection and processing of service quality and performance data, and helps ensure scheduling accuracy by recording the time, whereabouts and actions of employees and system users. It also tracks nonconformance and management response, measures productivity, processes work orders and maintains employee-training records.

Use of the information enables development of employee skills, human resource profiles, training and pictorial work schedules specific to each employee's need and routine.

Computer-aided asset tracking. Asset tracking systems help manage fixed and moveable assets, using hand-held readers and bar-code data to identify and track movement, service schedules and maintenance costs. For example, the system checks the location of the asset against the listed location to produce a variation report showing which assets have been misplaced, lost or found. It enables you to monitor maintenance costs by asset, asset group, employee, category and/or location. It also maintains an asset register, automatically logging preassigned asset values. Frequency, nature and cost of repairs can be tracked for each asset, allowing for better maintenance or purchasing decisions in the future.

Programs are capable of handling multiple categories, allowing the management of many different asset types, and possess an asset search function. Equipped with the right data, you have the ability to maximize maintenance and reduce replacement frequencies and costs. With the latest systems, such as AssetTRAC, you also can create

new maintenance routines and automatically compile planned preventive maintenance schedules.

Computer-aided stock management. Stock management bar coding and software programs can produce a wide variety of standard reports and analyze expenditure, revenue flow, allocation and use.

With portable bar code readers, you can perform stock audits, enter stock requisitions and factor in OSHA criteria in preparation for external audits of hazardous chemicals handling. Advances, such as the Stock-WATCH system, maintain inventory levels and flow for multiple stock rooms or warehouses, automatically re-ordering inventory when it falls below user-defined minimums. It also batches and processes purchase orders and special delivery notes.

Other advantages include the ability to process both consumable and rechargeable requisitions. A function for just-in-time ordering minimizes stockpiling.

Delivering High Quality Services

Bar coding is easy, quick, efficient and affordable. The cost savings can be significant using industry-leading software programs and technology, and when combined with proven systems of facility management, operations and cleaning. The result is a more predictable flow of information that gives managers greater control over precious resources.

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Raising the Bar for Vacuum Effectiveness

By Jennifer C. Jones

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

When the telephone rings at the Carpet and Rug Institute, it's often a consumer with a question. One of the most frequently asked is, "Which vacuum is best?" In the past, the answer depended upon whom you asked.

"Consumers want to take care of their carpets," says Michael Hilton, CRI's Technical Services Associate. "Vacuum marketing can be confusing. Consumers are confused about HEPA filtration, twelve amps vs. ten. Some vacuum manufacturers are making ridiculous claims about how they filtered when they didn't remove any dirt. If you don't remove anything, there's nothing to filter!"

According to Hilton, CRI members wondered about vacuum IAQ efficiencies. Schools were a special area of concern. Were children and cleaning workers being exposed to unacceptable levels of airborne particulate stirred up by vacuum cleaners?

In addition, many carpet manufacturers were branching out into carpet maintenance as well. Some of these members wondered which vacuum products to recommend to their customers or to purchase themselves.

CRI decided perhaps it was time to go looking for some more definitive answers. The Institute began work on a voluntary testing program that would allow vacuum manufacturers to test their products in three categories: soil removal, particulate emissions, and wear testing.

Carpet manufacturers welcomed the idea with open arms. "We were looking at it primarily from the fiber standpoint," says DuPont's Alan Luedtke, Product Steward for DuPont's nylon flooring systems. "Within the last ten years we've made a pretty dramatic push about how our products are used by our customers. Historically, there's never been much you could hang your hat on other than (vacuum) manufacturer claims," he says.

Dr. Howard Elder is Director of Research and Environmental Affairs for J and J Industries. "We want to provide carpet products that are environmentally friendly, including adhesives and pads. One part that's been missing is the cleaning system," he says. "We are marketing an entire system to the consumer, and that includes cleaning. As manufacturers, we want to have the entire package available to the consumer."

According to Elder, J and J's primary interest was not necessarily how much soil a certain vacuum brand would remove. "What we really want to do is understand something about how vacuum cleaners allow particles to escape into the air and be breathed," he says.

Both men felt a vacuum test conducted by the CRI, instead of individual manufacturers, would benefit car-

pet manufacturers. "It's not as fragmented to the consumer," says Howard Elder.

While the carpet side of manufacturing was generally supportive of the testing idea, vacuum manufacturers were much less enthusiastic. A majority of those first approached by CRI refused to participate. But a small core of vacuum makers saw the testing as a golden opportunity to promote and improve their products.

Castex was one of those companies. Mark Wierda, Key Account Sales Manager, explains why. "We see that vacuuming is the first line of defense in a good cleaning system. Most people, whether it's schools, hospitals or businesses, don't do a very good job vacuuming. Either they don't have the proper equipment or the proper program."

Michael Grubb, U.S. Sales Manager for Lindsay Manufacturing, says his company is fighting for better consumer education. "It's important that we don't just use a bunch of hype," he says. "If you're going to use hype, you better be able to back it up with good results."

ProTeam, a backpack vacuum manufacturer, was happy the industry was finally taking a hard look at IAQ. "In Pro-Team's case, filtration has always been one of the biggest keys with us," says Richard Coombs, the company's Engineering Manager. "We concentrate so much on filter efficiency."

Other vacuum manufacturers are also participating in the study. CRI officials wanted a good mix of vacuum models—everything from central vacuuming systems to backpacks and uprights. The Institute included models that could be purchased at local discount stores as well as commercial grade systems. Now CRI was ready to start establishing a benchmark for the testing. Mark Wierda sums it up: "Draw the line where ever you want, and we'll meet those standards."

It took vacuum and carpet manufacturers, as well as CRI officials, months to develop what they felt was an effective testing protocol. Michael Hilton recalls, "We didn't want to set something so easy everybody passed, or so tough the consumer would only have one or two options." CRI was also sensitive to the potential damage to manufacturers whose products failed the test. For that reason, each product was assigned an ID number, not a name, during the testing. In addition, the Institute decided not to release the test results. Using their ID numbers, manufacturers can get the results for their products only, not their competitors'.

Consumers who call with questions are told only that a machine passed. If a certain model fails the test, the

consumer is told there is no information available on that vacuum. Machines are not rated in comparison to one another—only in comparison to the test benchmark. Vacuums receive a Pass/Fail rating. In order to pass, the machine must meet acceptable levels in all three test areas: soil removal, emissions, and wear.

The testing would be conducted at an independent laboratory—Dalton, Georgia’s Professional Testing Labs—and monitored by three peer reviewers. The reviewers, Dr. Michael Barry, former Deputy Director of the EPA; Dr. Barry Ryan, Emory University, and Cornell’s Dr. Alan Hedge were selected. CRI chose the men for their reputation in environmental research and testing.

The peer reviewers were responsible for examining the protocol and evaluating it from an unbiased perspective. CRI asked this team to provide input and direction, based on their technical skills. The peer review group observed the testing, analyzed the results, and recommended where the pass/fail levels should be established.

The testing protocol itself was designed to be as accurate as possible. The Institute used 400 square inch samples of both cut and looped pile carpets. For the soil removal test, the carpet sample was first weighed and then attached to the side of a cylinder. The special cylinder spread a mixture of soil somewhat like a salt and pepper shaker, dispensing $\frac{1}{10}$ of a gram of soil per square inch of carpet. CRI chose 540 Wedron sand for this test—a mix similar to that used in earlier ASTM testing, only without the addition of talc. “It’s a very heavy sand and difficult to remove,” says Hilton.

Next the sample is placed on a table with the vacuum locked into position on top. The table moves the carpet sample back and forth at a rate of 1.8 feet per second. The vacuum makes just four passes. The carpet test sample is removed and weighed once again to determine the amount of soil that has been captured. Contents of the vacuum bag are also measured.

Emissions testing was conducted in a state-of-the-art environmental chamber with no outside air flow. The carpet sample is once again positioned on a moving table. The vacuum is stationary. Researchers used 5 grams of ISO fine road dust as the soil base. Each vacuum was operated for ten minutes. A special sampling device measured particulate emissions at approximately five feet above the floor—a cleaning worker’s breathing zone. The emphasis in this test was not the average emissions release. Instead, the test marked how much particulate was put in the air as soon as the vacuuming started. “It’s going to spike when you first start the vacuum,” Michael says. “It’s going to jump as high as it’s ever going to get, then it’s going to drop off. We’re concerned about the high point, not the average.”

For wear testing, the CRI relied on a black and white photographic scale. Each vacuum made 200 passes

across the carpet sample, moving at 1.8 feet per second. Then researchers compared the carpet sample to a photograph of the benchmark sample. They compared color and texture changes to determine a pass or fail rating.

Those who helped develop the testing protocol say this test is substantially different from earlier vacuum research. “We used some existing protocols and got as much as a 65% variation in results,” says CRI’s Michael Hilton. “The speed at which you pull the vacuum cleaner could produce about a 400% variation. That’s why we locked the vacuum in place and put a tachometer on the table that moved back and forth.”

Alan Luedtke says simple changes made a big difference in the credibility of the test. “What this test brings is better reproducibility. It will allow you to look at the relative performance.”

Lindsay’s Michael Grubb says the CRI program represents a new generation of testing. “Cleanability results were determined years ago by ASTM. The problem is, the carpet used at that time is almost gone. Issues like emissions and wearability have never been addressed.”

ProTeam believes this test comes closer to real world conditions than other vacuum research. “The more I worked with the protocol the more I agreed with it,” says Richard Coombs. “ASTM says you make ten passes. Who does that in the real world? CRI went a little bit beyond. They cut it back to four.”

The result of all this testing is the award of CRI’s Green Label. Vacuums that pass the test are allowed to display the special label certifying that they meet certain performance standards. “If you’re on the approved list, that’s the ultimate, the best you can get,” says Grubb. “You can see how effective a marketing tool that could be.”

With results only just beginning to be analyzed, there have been plenty of surprises. Less than half of the vacuums tested passed all three categories. Nevertheless, vacuum manufacturers remain undaunted. “We have the ability here to set a standard for vacuum cleaners which has never been done before,” says Mark Wierda, “Manufacturers can look at the vacuum and determine what it would take to meet the criteria, decide whether it was worth it to modify the vacuum or start a whole new product.”

“We have to find where our weak spots are,” says ProTeam’s Coombs. In spite of the fact the backpack had superior filtration results, the company rented the test lab for two additional days, at their own expense, to conduct even more testing. “We have to know which tool works best on which type of carpet,” says Coombs, “That allows us to help our customers.”

Michael Grubb says, “I believe no matter how it comes out, even if we should fail one of the tests, all that does is encourage us to improve our equipment.”

That's exactly what CRI hoped would happen. "We're not out to get anybody," says Michael Hilton. "If a manufacturer submits and fails, they'll be able to go back and re-engineer and re-tool."

DuPont's Luedtke says it's possible the Green Label program may change carpet manufacturers' cleaning recommendations. Right now the company is taking a "wait and see" position.

Test participants predict the consumer will be the big winner. "I would hope the consumers, once they find out

about the Green Label program, would be a little stingy and only use products that meet the guidelines," notes Hilton.

"If you buy a vacuum with this certification on it, you're going to be assured the machine will remove the dirt, not put a lot of emission in the air, and not harm your carpet over a long period of time," says Mark Wierda.

That, says Alan Luedtke, will result in happy consumers and better looking, longer lasting carpet products.

Ergonomics and Backpack Vacs

By Chris Murray

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

Ergonomics involves making workers *comfortable and safe* while they work, by designing equipment and processes that integrate with the body to allow low-stress activity for extended periods. However, the definition of ergonomics is much broader. According to OSHA's (Occupational Safety & Health Administration) "Advance Notice of Proposed Rulemaking for Ergonomic Safety and Health Management," 57FR34192, August 3, 1992: "Ergonomics seeks to fit the job to the person rather than the person to the job. The aim of the discipline is to prevent the development of occupational disorders and to reduce the potential for fatigue, error, or unsafe acts through the evaluation and design of facilities, environments, jobs, tasks, tools, equipment, processes, and training methods to match the capabilities of specific workers."

For this discussion, we'll focus on equipment, process, and training aspects related to backpack vacuum cleaners that facilitate good ergonomics and high productivity levels.

New Equipment Design: Building for Bodies & Productivity

Ergonomically sound design in backpack vacuums is vital because of the close physical relationship between a backpack and its user. While using backpacks is not new—think of footsoldiers, mountaineers, and mothers of toddlers—technology has made it easier. The mobility of backpack vacuums has increased productivity (the ISSA, International Sanitary Supply Association, estimates backpack vacuuming with a 14-inch tool allows cleaning 10,169 sq. ft. of floor surface per hour).

Engineers have reduced weight and improved harness design to make the vac more comfortable to wear. Some early backpack vacs had bulky steel bodies, clumsy harnesses, and weighed 20–30 pounds. Cylindrical design, modern materials, and efficient motors have pared the weight of many backpack vacs to under 10 pounds. Aluminum floor wands are lightweight and easily handled. Padded and contoured shoulder straps and waist belts distribute weight evenly around the hips. Adjustable backplates and harnesses allow custom-fitting the tool to the worker.

The Design Process: Harnessing Comfort

As opposed to carrying an object with hand and arm, carrying objects on your back helps maintain balance

and distribute weight equally to the body. Current backpack harness design, however, has less to do with the back, and more to do with the hips. Weight is transferred to the hips using a padded belt connected to the lower part of the backpack and secured around the user's waist. Shoulder straps, far from being a way to "hang" the pack on yourself, simply keep the pack from twisting or rotating.

Field studies show that shoulder straps should be curved in a natural position that does not interfere with the motions associated with vacuuming. In the field, conventional straps were reshaped from the straight position they were manufactured in to a curved position. After hours of use, operator motion while wearing the product formed the strap into a new shape. By analyzing this shape, engineers fashioned a form-fitted part, improving comfort.

Improving the Work Process: Team Methods

A 1993 NIOSH (National Institute for Occupational Safety and Health) report on backpack vacuums used at the Travelers' Insurance complex in Hartford, Conn., concluded, in part, that workers should be properly trained to use the equipment. The report also stressed that backpack fit, use, and worker complaints should be monitored and corrected, and workers be allowed some flexibility in choice of equipment.

Team cleaning seminars—focused on creating backpack vacuuming specialists as part of an integrated cleaning "team"—teach operators how to avoid unnecessary bending (a basic tenet of good lifting) and optimize labor. By training workers as specialists, operators become skilled, accustomed to the equipment, and most productive. Rotation of workers prevents burn out, and cross-trains the group. Of course, permanent specialists can be selected based on their aptitude or preference for tasks. You may wish to select backpack vacuuming specialists from among those who "take to" the process and enjoy using the equipment.

Ergonomic Training: Fit and Technique

It's crucial that any specialized tool be used properly, especially one attached to your body. Backpack vacuums must be worn and used properly for maximum comfort. The padded waist belt should fasten snugly around the hips, allowing shoulder straps to fit comfortably but

loosely. The primary weight of the unit should rest on the hips, not the shoulders, since shoulder straps serve mainly to balance the pack and prevent load shifting. The backplate—a ventilated panel that rests against the operator’s back and supports the vacuum unit—if adjustable, should be positioned according to the height of the operator. Backplate adjustment raises or lowers the vacuum relative to the operator to facilitate a range of torso sizes for convenient movement and use.

The upper body should stay upright with little twisting during backpack vacuuming.

For maximum productivity without fatigue, a side-to-side fanning technique with a lightweight aluminum vacuuming wand (a motion similar to mopping) allows rapid vacuuming without back bending or other biomechanical stress. Workers who can mop a floor without undue fatigue or discomfort are able to use a backpack vacuum using a similar motion for long periods.

When vacuuming underneath large desks or other furnishings, vacuumers should bend their knees rather than their backs. By bending at the knees, and using the vacuuming wand to get into hard to reach areas, no undue demands are placed on the back.

An often-neglected technique that makes vacuuming both easier and more effective is keeping the vac bag emptied. Emptying the bag frequently lightens the unit, keeps filter pores clean to trap maximum dust, and maintains airflow for good suction and motor cooling.

Knowing these simple techniques isn’t enough, however. Vacuumers need time to adapt to new equipment and develop the right habits. Workers require hands on training and a practice session or two to get the feel of the backpack, and learn to use the tool without improper bending, twisting, or lifting. Observe workers, monitor complaints if any, and coach them in correct technique by studying your best vacuumers. Teach them to emulate methods that work.

Physical Fitness

Sometimes equipment, process or technique is not at fault when workers experience discomfort or fatigue on the job. A lack of physical fitness is often the problem. Blaming cleaning tools or tasks for fatigue and discomfort in poorly conditioned workers is like blaming the road for the breakdown of a poorly maintained automobile.

Many corporations in industrialized nations, including those in the U.S. and Japan, encourage workers to exercise regularly since fit workers are more productive, injury and stress-resistant. Could cleaning and maintenance personnel benefit from company sponsored exercise programs? Could this reduce the number of “ergonomic complaints”? The answer is yes.

Exercises that strengthen the arms and legs, abdominal muscles, and lower back, are especially helpful for workers who perform tasks involving physical exertion, such as scrubbing or mopping floors, operating backpack vacuums, and emptying or carrying solution-laden mop buckets. Cardiovascular training via aerobic workouts increases endurance and mental alertness, traits vital to good cleaning.

Plainly, ergonomics is a broad discipline involving both the health of the worker and the design of equipment and processes the worker encounters. Optimizing conditions in a multifaceted approach dealing with the full reality, makes sense. Employees equipped with the right ergonomically designed equipment, processes, technique and physical training will not only feel better, they’ll clean better. Like a customized exercise program, the results are worth the effort.

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What Your Customers Need to Know about Vacuum Filtration

By Larry Shideler

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

The use of *efficient vacuum cleaners and filters* can significantly improve indoor air quality (IAQ), according to an Environmental Protection Agency (EPA) study. The one-year study, conducted at the Frank Porter Graham Child Development Center in Chapel Hill, North Carolina, found that efficient vacuum cleaners, along with an organized cleaning program, can greatly reduce the level of dust, bacteria, and fungi found in carpet and ambient air.

The study is important, EPA Research Analyst Jeff Bishop said, “because it provides authentic baseline information on how specifically to improve indoor air quality with relatively simple maintenance.”

Interestingly, the study found that surface and carpet levels of dust and bacteria correlate with airborne levels, showing that dust distributes itself evenly within a facility, and that the proverbial “white glove test” has validity in determining not only cleaning quality but overall IAQ levels. Important among methods of reducing whole building dust levels was the use of high-efficiency vacuum bags or filters.

Filter Factors

Few cleaning processes are as important to IAQ as vacuuming, and few internal steps are as important to the process as vacuum filtration. Without proper filters to catch dust, fine particulate is blown through the filter media and into the ambient environment. A vital factor to assess in choosing a vacuum filter is both the size of dust particles—measured in microns—and the quantity of dust particles removed from the vacuum’s airflow.

Microns Matter

A micron is one millionth of a meter, $\frac{1}{1,000,000}$ th the thickness of a human hair. Single dust particles smaller than 10 microns are so tiny they are virtually invisible.

When the main interest was in removing *visible* dirt, traditional cloth or paper bags filtering down to 10 microns were widely used. Vacuums that could effectively remove particles smaller than that were considered specialty items—valued only for stringent applications like computer data centers.

Now buildings are “tighter”—with less air exchange to dilute airborne dust—and people are reacting to the respirable particles (mostly ranging between 1–10 mi-

crons) they are breathing in many energy efficient facilities. Statistics indicate 50 million Americans, one of every five people, suffer from allergen-related diseases. Many allergic reactions are caused by airborne carpet and upholstery fibers, pet dander, molds, spores, dust, dirt, bacteria, and the feces and body parts of dustmites, dispersed by inefficient vacuuming.

While many filters remove dust down to one micron, the critical question is, how much one micron dust is captured? Less desirable filter arrangements may capture only 30% of one micron particles, while better filter configurations allow removing 99% or more of those particles. That brings us to the issue of filter *efficiency*.

Efficiency

“Filter efficiency”—expressed as a percentage—denotes how much dust of a particular size a filter captures. For example, a filter that is 95% efficient at one micron, catches 95% of all particles that size.

By contrast, an advertised “1 micron filter” (capable of removing particles as small as 1 micron) may be retaining only 30 percent of all 1 micron particles, while the remaining 70 percent pass through the filter and escape. That filter would have a 30 percent efficiency rating at one micron. Conversely, if the filter arrangement removed 99 percent of all 1 micron particles, it would have an efficiency rating of 99 percent. Typically, old-style cloth bags have an efficiency rating of only about 30 percent at one micron.

Airflow Issues

Airflow and air volume create suction, traits relating closely to effective filtration, since dust must be adequately pulled into the filter’s mesh without being pulled *through* the media by too much pressure. An integral part of the vacuum’s operating system, filters are only effective when they are carefully proportioned to the airflow and volume created by the vacuum motor’s fan. The filter *media* is also critical since material that catches fine dust must “breathe”—letting air pass through—to create sustained suction and cleaning ability. As you can imagine, developing materials that trap the finest dust while sustaining airflow is the goal of vacuuming engineers. Fortunately, there are several successful filter options that meet this need, depending on the intended application.

The Right Filters

In the past, when the main concern was the removal and capture of large noticeable debris and dust, old-style cloth or paper bags were considered adequate. However, with the current emphasis on IAQ and building wellness, a higher degree of filtration, usually in the form of layered micro filter media [this media is now used by a number of manufacturers of vacuum cleaners]—high-efficiency filters of several layers—is necessary to effectively remove and retain contaminants smaller than 10 microns.

Micro filters greatly increase vacuum efficiency. One study showed that a standard paper filter bag removed only 39.9 percent of debris 10 microns in size, while a micro filter bag removed over 99% of these particles. Likewise, a standard paper filter bag removed only 16.3% of one micron particles, whereas micro filters in two to four-stage configurations removed 95–96% of one micron debris. For this reason, micro filters are now increasingly used in commercial vacuuming applications.

Even greater filtration can be achieved with high filtration disc media.

Tests show this filter medium captures 99.79% of .3 micron particles (near HEPA efficiency) at a fraction of the cost of HEPA filters. The medium also removes 99.98% of 2 micron and 99.96% of 1 micron particles.

More sensitive vacuuming applications require high-efficiency particulate air (HEPA) or ultra-low penetration air (ULPA) filters. More costly than standard or micro filter bags or high filtration discs, both HEPA and ULPA filters are designed to remove more than 99 percent of superfine particles. HEPA filters remove 99.97 percent of particles .3 micron and larger in size. ULPA filters are even more efficient, removing 99.999 percent of .12 micron and larger particles. Both—typically installed as secondary filters “behind” primary filters that catch larger “gross” dust—rely on numerous brain-like folds or corrugations of filter media creating tremendous surface area in a relatively small package to trap fine contaminants without substantially restricting airflow. Watch out for ads for HEPA filtration, however, since many manufacturers’ claims are nothing more than marketing hype. True HEPA filtration requires balancing sufficient filter media with vacuum airflow.

Ensuring Sustained Suction

Old-style cloth and paper vacuum bags catch pollens, plant spores, and visible dust. Yet, particles quickly clog the pores of these filters, restricting airflow and signifi-

cantly reducing suction. As a result, vacuuming is less effective. More debris is left in the carpet or on the floor or—agitated by a beater brush—it is broken up and dispersed into the surrounding environment.

The use of micro filter technology has alleviated this problem to a large extent. Note the chart showing suction loss using a standard paper filter bag versus a bag composed of micro filter material when vacuuming 20–120 grams of fine road dust.

**Suction Loss
Standard Dust Bag vs. Micro Liner**

Grams of Road Dust	Standard	Micro-Liner
20	20.1%	2.1%
40	33.3%	5.3%
60	38.4%	6.1%
80	43.6%	9.2%
100	49.2%	12.2%
120	55.6%	15.8%

Despite the advances in vacuuming technology and filtration, one element of vacuuming is potentially more critical to maintaining good filtration than any other.

The Critical Vacuuming Part (People)

Having selected an appropriate filter combination for your application, the key to maintaining adequate suction and filtration is filter *maintenance*. Today’s filters—as opposed to the old style disposable single-layer paper bags—can be cleaned and reused several times, and vacuum technicians should be encouraged to do this on a regular basis, perhaps as often as every 30 minutes to two hours of vacuum time, depending on the soil conditions. Regular cleaning maintains suction and prolongs the life of the filter and the vacuum cleaner, resulting in more effective vacuuming and ensuring a healthier, more comfortable environment. Regular inspection of filters also allows detecting punctures that allow fine dust to pass through and contaminate the room. Clearly, beyond equipment, ensuring effective vacuuming and filtration means training and educating the *people* using the tools.

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The Science of Suction

By Larry Shideler

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

Vacuum cleaner suction is negative airflow that removes dirt from carpeting, fabric, and other surfaces. This is achieved using an internal fan rotating at high speed to create a partial vacuum, causing air at the tool head to rush to “fill” the vacuum—sweeping away debris in its path as it does so.

Removable soil must have sufficient air resistance to be caught in the airflow, making suction effective. Difficulties with removing certain kinds of soil stem largely from either its low relative air resistance (fine powders, soot, chalk dust), adherence to the surface (mud, lint), and/or low negative airflow or suction at the tool head.

Suction Variables

Suction is a product of several variables. Ideally, the internal fan is powered and proportioned to create “vacuum” for moving or suctioning a desired volume of air (measured as CFM—cubic feet per minute) in relation to the size of the tool head, the diameter and length of the airflow conduit (hose and internal air channel), and the type, size, and configuration of filter media.

Of course, proper air volume and suction would be simpler to achieve and maintain if filtering the air and retaining the dirt weren’t necessary. Without filter media (cloth and/or paper bags, HEPA, ULPA, and secondary types) to screen and hold particulate of various sizes, air passing through a vacuum cleaner would meet little resistances—suction would remain constant. The room environment would also be dirtier than ever, since dust removed from one end of the vac would simply be blown out the exhaust end.

Until recently, this occurred too frequently. Vacuum cleaner manufacturers sold equipment based largely on suction power and ease-of-pickup. Filters were “airy” and inefficient, trapping bigger particles (10 microns plus), while hefty motors and fans pumped fine particulate out the back of the unit. Exhausted particles increased the need for dusting and cleaning, prematurely clogged HVAC filters, and created allergic reactions in building occupants. Plainly, not all suction is *effective* suction.

Effective Suction—A System Approach

Effective suction is a product of an intelligent system—one that permits constant airflow with practical filtration to trap particles of soil, large or small. Hence, trying to

assess the *performance* of vacuum cleaners by individually comparing CFM numbers, amp ratings, filter type or size, etc., is at best a “part smart” approach. It’s how all the components work together that makes the vacuum work, not any one separately. The key component in a vacuuming system is the relationship between airflow and filtration—and the two are somewhat at odds.

Suction and Filtrations: Tips for Success

Excellent suction and excellent filtration sometimes form an uneasy alliance. High-efficiency filters that trap more fine particles often tend to clog more rapidly, choking airflow and suction, and lowering cleaning ability. Good filters, unless *cleaned* or replaced regularly, reduce vacuum performance.

Filter efficiency, filter access, and filter maintenance are important issues related to suction. Since indoor air quality affects both health and housekeeping concerns consider a four-stage system that filters at least 95–99% of dust down to one micron—most airborne dust falls into the one to ten micron range. Secondly, look for a vacuum that permits easy filter maintenance (if filters are difficult to change, operators will tend to allow them to clog reducing suction). Third, train operators to clean vacuum filters regularly (after every few hours of vacuuming or as needed to maintain optimum airflow and suction).

Conclusion

Effective suction is a product of the right vacuuming system, rather than any single element. So don’t be drawn into a discussion about whose vacuum has the most suction. It’s like evaluating a car based on which engine is bigger, and forgetting all about the suspension, the transmission, the tires, the brakes, the drivetrain, and of course, the driver!

A quality vacuum with a qualified operator is like a high-performance car with a skilled driver. A fine car, driven well, will reach its destination quickly and safely. Vacuuming programs arrive, when operators understand that effective suction is achieved through a combination of the right machine and the right maintenance to maximize performance.

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Exceeding Customer Expectations and Building Profit Margins with Team Cleaning

By John Walker, ManageMen

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

Distributors can exceed expectations for value-added service combined with savings by empowering customer staff with team cleaning. Implementing team cleaning means training and deploying task specialists to clean a facility by using “assembly line” methods, sequencing workers and tasks for maximum productivity and quality.

A team, however, doesn’t become a precision machine through random effort; well-defined roles for each member are essential, and those jobs must be integrated and balanced to achieve objectives.

“Team cleaning represents an absolute commitment to serve your customer,” according to Jeff Rosenstein of Diversified Supply, Humble, TX, “We go in and redesign their operations plan and the way they clean.”

Your function as a value-added distributor can be to assist customers in setting up teams, and recommending equipment that facilitates a team approach. Equipment manufacturers, who promote team cleaning, can also provide considerable help.

Team cleaning initially involves assessing tasks needed to produce a clean building, then distributing the workload among specialists or team members. “Instead of having one person responsible for numerous tasks, we have individuals responsible for certain tasks. It makes workers far more efficient and productive,” Rosenstein says.

Specialists perform tasks better and with greater speed, and combining their respective complementary skills in the proper sequence produces time and quality benefits. When each staff member performs his/her specialty throughout a facility without interruption, momentum and straight-line efficiency are maintained.

Workloading with team cleaning typically involves four basic specialists comprising a team, who work from point-A-to-point-B covering maximum ground: 1) A light-duty specialist to empty trash, dust horizontal and vertical surfaces, clean telephones, etc., 2) A vacuum specialist equipped with a backpack unit for multiple surface cleaning who follows 30 minutes behind the first team member, spot-checks the work of the previous worker, turns out lights and secures the area, 3) A restroom specialist who also cleans hallway water fountains and other designated areas, and 4) A utility specialist who cleans and buffs floors, details entrance glass, etc.

Tools which enable multitasking—that is, performing several related functions simultaneously—optimize the

team cleaning method. Modern backpack vacuum systems actually fostered the idea for and especially lend themselves to team cleaning applications. With an excellent power-to-weight ratio, suction-only backpacks, permit carpet, hard floor, stairwell and detail cleaning in one pass, with greater soil removal than conventional systems. Sealed four-stage filtration captures more dust than other systems, and reduces IAQ problems.

Lightweight backpacks increase efficiency by enabling one trained individual—the vacuum specialist—to clean up to 10,000 square feet per hour, simplifying team duties by consolidating work.

Here are examples of simple, effective products that can help your customers integrate team cleaning with four basic specialists.

- *Light Duty Specialist—Dedicated to dusting, spot-cleaning and emptying trash*

Suggestions: A mobile waste collection system such as a resin-molded polyethylene refuse barrel equipped with wheels and fitted with a wrap-around apron or caddy with pockets for holding spot-cleaning spray solution, dusting cloths, and poly liners of various sizes.

Application: Light-duty specialist rolls the waste collector and tools directly to the location where needed, dusts, spot-cleans, empties trash and replaces liners in fluid motions, then rolls/moves to next location.

- *Vacuum Specialist—Dedicated to vacuuming carpeting, hard floors, upholstery, other surfaces*

Suggestions: Lightweight backpack vacuuming system with four-stage filtration, ergonomic design and harness for distributing weight across hips, and strap-mounted attachments.

Application: Vacuum specialist works systematically throughout the facility, using a side-to-side six-foot fanning technique with a lightweight vacuuming wand to clean carpeted and hard floor areas with minimal fatigue. Multi-tasking—performing several tasks in one trip with the same equipment—streamlines vacuuming throughout the building. With simple tool changes, this worker can clean upholstery, carpet edges, corners, stairwells, A/C vents, etc., according to the building’s cleaning specifications.

Sealed four-stage filters in one-piece backpacks capture more dust than unsealed systems, enhancing indoor air quality and reducing dusting.

- *Restroom Specialist*—Dedicated to cleaning and sanitizing restroom fixtures and floors, and drinking fountains

Suggestions: A restroom cart holding plastic mop bucket with fill-line markings, mop, other tools, restroom supplies, color-coded portion control packets for point-of-use mixing, color-coded spray bottles for glass cleaner, and disinfectant, etc.

Application: Restroom specialist uses pre-measured pouches of concentrate to make additional glass cleaner, disinfectant, and mopping solution on location as needed without having to make trips to the supply closet. Color-coding of all products eliminates mistakes. Pre-measured packets create ideal dilutions and facilitate point-of-use mixing, encourage prescribed mop water changes, and enable better quality monitoring and inventory control (workers return empty packets to supervisors at shift completion).

- *Utility Specialist*—Dedicated to cleaning entrance glass, lobbies, other flooring, etc.

Suggestions: Since the utility specialist is a “clean up hitter”—focusing on miscellaneous tasks according to the building’s specifications—equipment is contingent on duties. For entrance glass spot-cleaning, a plastic spray bottle containing glass cleaner, lint-free cloths, a holster or apron to hold sprayer and extra trigger/head, pre-measured glass cleaner concentrate packets for point-of-use mixing, etc. For floor cleaning, mop bucket and mop, with prescribed number of concentrate packets carried in holster or apron to facilitate solution changes without wasted trips. The utility specialist often uses a backpack vacuum for cleaning entrance areas and lobbies, a cart to carry supplies and pick up bagged refuse, depending on the scope and nature of duties.

Application: Performs various tasks throughout a facility, including glass cleaning, floor care, peripheral vacuuming, etc., and picks up trash bagged by the light-duty specialist at scheduled times for each floor, depositing it in an outside dumpster.

Equipment and Staff Comparisons between Zone and Team Cleaning

Example: Eight-story office building, 12,000 square feet per floor, 96,000 total sq. ft.

ZONE CLEANING: Staff of eight (one for each floor)

Required Equipment: Eight vacuums, eight trash barrels, eight restroom carts (adjusted according to building specs)

TEAM CLEANING: Staff of six specialists (two vacuumers, two light-duty task persons, one restroom person, and one utility person)

Required Equipment: Three vacuums, two trash barrels, one restroom cart, and two utility carts (adjusted according to building specs)

Important: In team cleaning programs, fewer tools are required and workers are typically assigned their own tools, which creates ownership and better care and maintenance of equipment, leading to leaner supply budgets.

With team cleaning, efficiency is also produced through a double-check system and supervision. Forgetting to empty trash, etc., is a problem eliminated by built-in cross-checks in team cleaning. For example, since the vacuum specialist follows the light-duty specialist, this person checks the trash, and empties it if missed by the first specialist.

With zone cleaning—since each floor is cleaned by a different person—a supervisor must look at *each* floor to determine work quality, but with team cleaning, the supervisor can spot-check two floors and two restrooms at random, and assess overall quality.

In team cleaning, since the workload and equipment are streamlined, individuals have a thorough knowledge of their functions and responsibilities. As the cleaning industry becomes more complex, it’s important to clearly define each employee’s duties. This can be achieved simply with team cleaning.

“Team cleaning has cemented our relationship with our customers,” says Rosenstein. “They know that we are constantly on the lookout for ways to enhance their productivity. You’re always stretching that goal a little further, expanding the envelope. We try to set everybody up, so that liability is minimized, and compliance with new laws is met. We try to set everything up so that cleaning is as safe and simple as possible. This reduces their exposure. It’s a complete integrated approach.”

Improvements in Vacuum Cleaner Soil Removal Effectiveness Mean New Ways to Save on Facility Budgets

By Robert A. Woellner

(This article is presented through the generosity of ProTeam Inc., a Boise, Idaho, manufacturer of backpack vacuum systems and sponsor of Team Cleaning Seminars.)

As the quality of carpets has increased over the past decade, the quality of carpet vacuum cleaners has also improved dramatically. Although proactive representatives from the two industries have worked together, it is not uncommon for misconceptions to remain. Many representatives of each industry have not adequately kept up-to-date with the developments of the other industry, and in many cases are using the biases of decade old information.

One of the most significant misinformed theories is that upright vacuum cleaners using “beater-bars” are more effective than suction vacuum cleaners at removing soil from carpets. With this misconception, many manufacturers incorrectly recommend that their carpets be maintained with upright vacuum cleaners. Several warranties still mandate the use of upright vacuum cleaners. Numerous studies over the last five years have concluded that not only do many modern commercial and industrial backpack vacuum cleaners favorably compare to upright vacuum cleaners, but commercial backpack units are now often more effective at removing dirt from carpets.

Soil removal effectiveness is the measure of how effectively a known concentration of soil is removed from a carpet and captured in a vacuum cleaner’s filter bag. An increase in the effectiveness of soil removal from a carpet not only prolongs the life of the carpet, but allows carpets to be cleaned faster. This increase in efficiency can provide a significant economic benefit to commercial buildings.

This article summarizes the results of studies conducted by an independent testing laboratory (Quality Environmental Services & Technologies, Inc., “QUEST”) comparing the soil removal effectiveness of several brands of commercial/industrial vacuum cleaners. This article is not intended to provide all the supporting data, since it is provided elsewhere and is available from the author.

In the designing of testing procedures, the following test methods were reviewed and sections included as appropriate: Standard Laboratory Test Method for Evaluation of Carpet Embedded Dirt Removal Effectiveness of Household Vacuum Cleaners (ASTM Method F 608-89); Standard Test Method for Measuring Air Performance Characteristics of Vacuum Cleaners (ASTM Method F 558-88); Specification for Air Performance Measurement Plenum Chamber for Vacuum Cleaners

(ASTM Method F 431-87); Specification for Test Carpets and Pads for Vacuum Cleaner Testing (ASTM Method F 655-89); and ServiceMaster Vacuum Cleaner Testing Protocol.

The purpose of the testing was to utilize reproducible testing protocols to compare the soil removal effectiveness of commercial/industrial vacuum cleaners. An attempt was made to approximate real life conditions in a controlled environment. Since no ASTM methods specifically address the soil removal effectiveness of industrial type vacuum cleaners (most test methods focus upon residential units), the following testing procedure was designed and utilized:

Soil Removal Effectiveness

Soil removal effectiveness was tested by evenly distributing 100 grams of test soil (80% silica sand and 20% talcum powder) onto a 6’ by 6’ commercial grade test carpet, working the test soil into the carpet with a carpet rake, vacuuming the test carpet for 60 seconds, and removing and weighing the pre-weighed filter bag. The percent of test soil picked up and retained in the filter bag was calculated and is presented below by vacuum cleaner type.

Vacuum Cleaner Type	Soil Removal Effectiveness	Range of Results
Backpack Vacuum	95.7%	95.3–96.1%
Two Motor Upright	94.0%	92.9–94.9%
Backpack Vacuum	93.7%	92.1–95.3%
Backpack Vacuum	93.3%	91.3–95.3%
Two Motor Upright	92.2%	87.9–94.2%

Conclusions

Of the units tested, a backpack style vacuum was consistently the top performer with regards to both soil removal effectiveness and filtration efficiency. The high soil removal effectiveness of the commercial backpack vacuum cleaners appears to be the result of a combination of high airflow at the point of carpet contact which is concentrated over a smaller area than with a typical upright vacuum cleaner and successful trapping of the soil in the filter bag.

This data, along with the findings of other recent studies, should encourage the carpet manufacturing industry

to retest and rethink their old notions that an upright vacuum cleaner with a beater-bar helps maintain the life of a carpet. Upright vacuum cleaners are no longer the only option for optimal carpet maintenance.

Additionally, those interested in indoor air quality and the cost savings of improved efficiency cleaning should find comfort in the fact that backpack vacuum

cleaners can provide improvements in both soil removal effectiveness and airborne particulate emissions.

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