ASSESSMENT, CLEANING & RESTORATION OF HVAC SYSTEMS (ACR-2002)

C Cochrane* and T Yacobellis

National Air Duct Cleaners Association ACR 2002 Committee, Washington, DC, USA

ABSTRACT
In the fall of 2001 NADCA released ACR 2002, which supercedes 92-01. This new standard holds to the same clearance criteria for post cleaning requirements but goes much farther in addressing pre-cleaning assessments, control and containment during the cleaning process as well as a host of other variables that can impact the indoor environment. This paper takes a look at the new standard and how it addresses the many variables that influence duct cleaning and IAQ and how the document deals with the many different building populations.

INDEX TERMS
HVAC System Cleaning, Duct Cleaning, HVAC Hygiene

INTRODUCTION

ACR 2002, embodies many of the key elements of NADCA's first standard for ventilation cleaning 92-01 such as verification and equipment performance; however, this new document also draws from a wealth of information that has been gleaned since the first document was introduced more than a decade ago.

This paper cannot cover the entire scope of the new standard but rather will focus on the substantive changes that were incorporated. The knowledge gained over the last decade from field information, joint NADCA and EPA research as well as information from around the world made it clear that the scope and impact of the practice of duct cleaning goes beyond the HVAC system and involves the building, occupants, climate and a host of other issues.

The principle changes from the original standard to ACR 2002 include, determining the need to clean, project assessment, and Environmental engineering controls. This paper has drawn excerpts from the standard that define the key changes.

Section 3 Determining the Need for HVAC System Cleaning and Restoration (Cochrane, Yacobellis, Long, *et al.*, 2001)
HVAC systems should be cleaned when an HVAC cleanliness inspection indicates that the system is contaminated with a significant accumulation of particulate or microbiological growth. If the inspection shows that HVAC system performance is compromised due to contamination build-up, cleaning is necessary. Often HVAC systems become contaminated during construction activities within a building. Newly installed HVAC systems should be clean before operated. HVAC system inspections must be part of a building's overall indoor air quality management program.

Section 3.1 HVAC Cleanliness Inspection Schedule (Cochrane, Yacobellis, Long, *et al.*, 2001)

* Contact author email: iaqcvi@aol.com

HVAC systems should be routinely inspected for cleanliness by visual means. The table below provides a recommended inspection schedule for major HVAC components within different building use classifications. The inspection intervals specified in Table 1 below are minimum recommendations. The need for more frequent cleanliness inspections is subject to numerous environmental, mechanical and human influences. Geographic regions with climates having higher humidity, for example, will warrant HVAC system inspections on a more frequent basis, due to the increased potential for microbial amplification. If the inspection of the air handling unit reveals contamination, then supply and return ductwork must be inspected at that time rather than in accordance with the intervals specified in Table 1.

Table 1. HVAC Cleanliness Inspection Schedule (Recommended Intervals)

Building Use Classification (see Section 4.1)	Air Handling Unit	Supply ductwork	Return ductwork / Exhaust
Industrial	1 year	1 year	1 year
Residential	1 year	2 years	2 years
Light Commercial	1 year	2 years	2 years
Commercial	1 year	2 years	2 years
Healthcare	1 year	1 year	1 year
Marine	1 year	2 years	2 years

Section 3.2 HVAC System Component Inspections (Cochrane, Yacobellis, Long, *et al.*, 2001)
The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of the units should be inspected.

Section 3.2.1 HVAC SYSTEM Inspections (Cochrane, Yacobellis, Long, *et al.*, 2001)
The air handling unit (AHU) cleanliness inspection should consider all components within the unit, including filters and air bypass, heat and cooling coils, condensate pans, condensate drain lines, humidification systems, acoustic insulation, fan and fan compartment, dampers, door gaskets and general unit integrity. The supply duct cleanliness inspection should consider a representative portion of ductwork, controls, mixing / VAV boxes, reheat coils and other internal components The return duct cleanliness inspection should consider a representative portion of return system components including but not limited to return ducts, dampers, return plenums, makeup air plenums and grilles.

Section 3.3 Microbial Contaminants (Cochrane, Yacobellis, Long, *et al.*, 2001)
The HVAC system cleanliness inspection should include a check for microbial contamination. The inspection should evaluate the air handling unit, humidifier and other representative system areas for microbial growth. HVAC systems should be inspected at least twice annually when they have supplemental humidification or when they are in hot and humid climates. When microbial sampling is performed, it shall be in accordance with ACGIH and AIHA industry guidelines (See Applicable Documents section).

Section 3.4 Inspector Qualifications (Cochrane, Yacobellis, Long, *et al.*, 2001)
Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system

design, and experience in using accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

Section 3.5 Conditions Requiring Cleaning (Cochrane, Yacobellis, Long, *et al.*, 2001)
HVAC system cleaning shall be performed when any of the following conditions are found in the cleanliness inspection.

Section 3.5.1 HVAC System Contamination (Cochrane, Yacobellis, Long, *et al.*, 2001)
HVAC systems should be operated in a clean condition. If significant accumulations of contaminants or debris are visually observed within the HVAC system, then cleaning is necessary. Likewise, if evidence of microbial growth is visually observed or confirmed by analytical methods, then cleaning is required. If the HVAC system discharges visible particulate into the occupied space, or a significant contribution of airborne particles from the HVAC system into the indoor ambient air is confirmed, then cleaning is necessary. See the guideline to this standard for discussion of the Aggressive Particle Profiling procedure, which may be used to confirm if non-visible contaminants are being introduced into the indoor environment via the HVAC system.

Section 3.5.2 Compromised Performance (Cochrane, Yacobellis, Long, *et al.*, 2001)
Heat exchange coils, cooling coils, air flow control devices, filtration devices, and air-handling equipment determined to have restrictions, blockages, or contamination deposits that may cause system performance inefficiencies, air flow degradation, or that may significantly affect the design intent of the HVAC system, shall be cleaned.

Section 3.5.3 Indoor Air Quality Management (Cochrane, Yacobellis, Long, *et al.*, 2001)
Indoor air quality management plans that include preventative cleaning and maintenance are recommended to minimize recurring contamination within HVAC systems. Special consideration should also be given to buildings or residences with sensitive populations such as immune-compromised individuals, and specialized environments or buildings with sensitive building contents or critical processes.

Section 4 Project Assessment (Cochrane, Yacobellis, Long, *et al.*, 2001)
A Project Assessment must take place prior to commencing with cleaning work. The Project Assessment includes three steps: (1) Building Usage Classification; (2) HVAC Contamination Evaluation; and (3) Environmental Impact Assessment. The HVAC Contamination Evaluation and the Environmental Impact Assessment must include a visual evaluation of representative sections of the HVAC components and the occupied spaces served by the HVAC system. This evaluation serves to assess conditions within the HVAC system and the physical integrity of system components and surfaces. Information collected from the Project Assessment should be used to define the scope of the cleaning and restoration project, cleaning methods to be employed, the environmental engineering controls required for the workspace, and any unique project requirements.

Section 4.1 Building Use Classification (Cochrane, Yacobellis, Long, *et al.*, 2001)
Classifying the type of building and its uses is an important part of Project Assessment. Cleaning methods, project specifications, environmental engineering controls, and cleanliness verification methods may vary among different buildings. Building Use classifications are noted in Table 1.

Section 4.2 HVAC Contamination Evaluation (Cochrane, Yacobellis, Long, *et al.*, 2001)
Cleaning methods, project specifications, environmental engineering controls, and cleanliness verification methods may vary depending on the type of contaminants found within a building and its HVAC system. Recognizing the type of contaminants present and the type of HVAC system(s) within the building are important parts of the overall project assessment. The HVAC systems, including air handling units and representative areas of the HVAC system components and ductwork, must be evaluated for contamination levels. An HVAC system component is considered contaminated when evidence of significant particulate debris and/or microbial growth exists. A system is considered to have microbial contamination when the HVAC cleanliness evaluation identifies microbial growth through visual inspection and/or analytical verification. Relative to the classification of the building, the types of contaminants present shall determine cleaning methods and environmental engineering controls required. The scope and extent of the evaluation shall be the same as that employed in section 3.2.1.

Section 4.3 Indoor Environmental Impact Assessment (Cochrane, Yacobellis, Long, *et al.*, 2001)
The activities associated with HVAC system hygiene evaluation work, system cleaning, and restoration of HVAC components, have the potential to adversely influence a building's indoor environment if not properly performed. Of primary concern is the disturbance of materials and the potential for release of contaminants into occupied areas.

Section 5 Environmental Engineering Controls (Cochrane, Yacobellis, Long, *et al.*, 2001)
During HVAC system cleaning procedures, appropriate environmental engineering controls must be established to control contaminants associated with the project from migrating to other spaces in the building. The effectiveness of environmental engineering controls may be demonstrated by appropriate monitoring. Monitoring is highly recommended in buildings containing sensitive environments or contents, when occupants have special health considerations, or when hazardous or biological contaminants within the system warrant such monitoring.

Section 5.1 HVAC Duct Pressurization (Cochrane, Yacobellis, Long, *et al.*, 2001)
HVAC ducts shall be kept at an appropriate pressure differential relative to surrounding indoor occupant spaces during all cleaning procedures and as may be required during assessment activities. It must be possible to demonstrate pressurization differential.

Section 5.1.1 Vacuum Collection Equipment and Negative Air Machines (Cochrane, Yacobellis, Long, *et al.*, 2001)
Vacuum collection equipment or a negative air machine must be used to establish pressure differential in the portion of the HVAC system being serviced. The device must be operating in close proximity to the service opening connecting it to the HVAC system. Negative air machines shall not be used to collect large quantities of debris unless designed for that purpose.

Section 5.1.2 Pressure Differential Requirements (Cochrane, Yacobellis, Long, *et al.*, 2001)
An appropriate pressure differential shall be maintained between the portion of the HVAC ductwork system being cleaned and surrounding indoor occupant spaces. The pressure differential on those portions of the HVAC system undergoing cleaning should be verified at representative locations during the cleaning process.

Section 5.2 Work Site Containment (Cochrane, Yacobellis, Long, *et al.*, 2001)
Physical activities within an indoor environment are likely to cause a temporary rise in airborne particles. Work site containment shall be used to create a barrier between the work site and the rest of the building, reducing the opportunity for particles to cross contaminate other areas. The extent of work site containment controls employed on a particular cleaning project is dependent upon the building use classification, HVAC system contamination evaluation, and indoor environmental impact assessment.

Section 5.3 Cleaning Equipment (Cochrane, Yacobellis, Long, *et al.*, 2001)
Tools, equipment, and instrumentation brought onto the work site shall be clean and must not introduce contaminants into the indoor environment or HVAC system. All equipment shall be serviced as needed throughout a project to limit possible cross contamination from poor hygiene, or unsafe operating conditions for service personnel and building occupants. These requirements apply to all cleaning projects. In cases of severe microbial growth, or where hazardous substances are known to be present within the HVAC system, or on projects taking place within healthcare facilities, there shall be an on-site hygiene/integrity inspection of vacuum collection equipment prior to commencement of work. The building owner or his representative should conduct the inspection.

Section 5.3.3 Vacuum Equipment Filtration (Cochrane, Yacobellis, Long, *et al.*, 2001)
When using vacuum collection equipment exhausting within the building envelope, the equipment must utilize HEPA filtration with 99.97% collection efficiency at 0.3 micrometer particle size. This requirement applies to all cleaning projects.

Section 5.3.3.1 Work Site Filtration Efficiency Certification (Cochrane, Yacobellis, Long, *et al.*, 2001)
In cases of severe microbial infestation, or where hazardous substances are known to be present within the HVAC system, or on projects taking place within healthcare facilities, filter certification by DOP testing of HEPA-filtered collection equipment at the work site is recommended prior to commencement of work.

Section 5.4 Smoke and/or Fire Detection Equipment (Cochrane, Yacobellis, Long, *et al.*, 2001)
Cleaning activities shall not impair, alter or damage any smoke and fire detection equipment located within the facility or attached to and serving the HVAC system. When required, temporary modifications, alterations, deactivation and reactivation of smoke and fire detection equipment, special permits, code-required notification, or other communication shall be the responsibility of the facility owner or the owner's designated representative.

Section 5.4.1 Temporary Controls (Cochrane, Yacobellis, Long, *et al.*, 2001)
Conditions may require temporarily disabling detection equipment to avoid damage and false alarms. When temporary controls are used, confirmation that all such devices were properly functioning shall be documented, and if needed, confirmed through testing.

Section 5.4.1.1 Authority Notification (Cochrane, Yacobellis, Long, *et al.*, 2001)
When detection equipment is deactivated, disabled or reactivated, it is the responsibility of the facility owner or his representative to inform the authority having jurisdiction about detection equipment status.

Section 5.4.1.2 Safety Plan (Cochrane, Yacobellis, Long, *et al.*, 2001)
When detection equipment is off-line, disabled, and subsequently reactivated, it is the responsibility of the facility owner or his representative to develop a plan for assuring safe operation of the building during such periods. The safety plan shall conform to life safety regulations. The plan shall define the responsibilities of each organization's designated representative involved with executing the plan for the duration of the HVAC system cleaning project.

Section 5.5 Building Pressurization and Depressurization (Cochrane, Yacobellis, Long, *et al.*, 2001)
The impact of HVAC cleaning activities on building pressurization and depressurization shall be considered for all buildings. Potential hazards and adverse conditions resulting from dynamic building pressurization or depressurization might include back-drafting, extinguishing and/or flame roll-out of combustion appliances, altered fume-hood exhausts, adjacent thermal and relative humidity conditions, introduction of outdoor pollutants, and other problems. Appropriate environmental engineering controls shall be employed to safeguard the building environment and to control equipment that could be adversely affected by dynamic building pressurization during HVAC system cleaning processes.

Section 5.6 Chemical Application Controls (Cochrane, Yacobellis, Long, *et al.*, 2001)
The use of chemicals in cleaning and restoration shall comply with any local, regional, or national standards and/or laws regulating the use of such agents. Cleaning agents, biocides, or other chemicals shall be applied in accordance with the manufacturer's written recommendations for proper handling, usage, and disposal. Biocides shall be properly registered for use in HVAC systems by the EPA or the applicable governing agencies, and used in accordance with their registration listing. Any application of cleaning agents, biocides, or other chemical agents shall be performed in such a manner as to minimize employee and occupant exposure and cross-contamination.

Section 5.7 Control of Contaminants (Cochrane, Yacobellis, Long, *et al.*, 2001)
All contaminated materials removed from the HVAC system shall be properly contained to prevent cross-contamination. Removed debris should be double-bagged and sealed in 6-mil polyethylene bags. Materials deemed to be hazardous by governmental agencies must be handled in strict accordance with any applicable local, regional, or national codes. All vacuum collection devices used in the removal process shall be sealed prior to relocation or removal from the building. Any activity requiring the opening of contaminated vacuum collection equipment on site, such as servicing or filter maintenance, shall be performed in a negatively pressurized containment area or outside the building.

Section 5.8 Project Planning (Cochrane, Yacobellis, Long, *et al.*, 2001)
Project planning is required for all HVAC system cleaning projects. The project plan shall address all aspects of the project from site preparation to job completion and must address all variables that have the potential to impact the project, building, occupants or outcome. The project plan shall also take into consideration those variables that may be beyond the direct contol of the remediation contractor but have the potential to impact the project.

REFERENCE

Cochrane, Yacobellis, Long, *et al.* 2001. *ACR 2002*: *Assessment, Cleaning & Restoration of HVAC Systems*, Washington, DC: National Air Duct Cleaners Association, Inc.