The Use and Benefits of Video Inspection in Lined and Unlined Ductwork in IAQ Surveys and "Source Removal" Cleaning Projects.

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SYNOPSIS:

New technology has developed video equipment capable of inspecting interior lined and unlined ductwork. Where IAQ (Indoor Air Quality) questions require inspections of suspicious air conveyance systems. Video recordings provide useful information to locate, identify and help execute "source removal" techniques.

After cleaning, the owner or building manager can inspect the cleaning services and decontamination of the system.

OUTLINE:

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II. Why is Video Inspection necessary?

III. Equipment Specifications

IV. Method of Operation

V. Description of Results

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OVERVIEW OF VIDEO INSPECTION

In buildings where air conveyance duct work has been suspect of causing excessive dirt, dust, strange (sometimes foul) odors, sinusitis, headache's and sore throats; indoor air quality surveys are used to determine the source of the problematic contaminant.

Certain situations require visual inspections of the mechanical unit, coils fans, motor, drain pan, and of a plenum. If a source of contamination is found, then it is necessary to resolve the extent of the contamination in the duct work system, the nature of the contaminant, the exact location in the duct work and a plan of attack for "Source Removal" techniques and equipment.

Remote Operated Cameras [ROC] have provided access to recessed areas of the ductwork where direct visual inspection is not practical, too time consuming or not cost effective. The ROC allows inspection of duct work seams, internal lining, reheaters, turn vanes and auxiliary fans without having to cut into the ductwork or physically putting an inspector into the duct (a practice we do not advise). Using a video television monitor, the operator can direct the vehicle down the ducts and focus on the internal areas without detrimental disturbance of the contamination. By adjusting the light, focus, color contrast, proximity and viewing wide angles the operator gathers significant information about the physical nature of the contaminant. An exact location can be determined in the duct, allowing a "source removal" point to be determined. Normally the power cord is used as a measuring tape. The location is based on footage from the access port or feet from a known drop down, register or device in the duct work. The consistency, generic identification (mold, dirt, frayed insulation, lost instrument, insect nest etc.), extent of duct coverage and degree of attachment, will determine the equipment necessary for removal.

The equipment used in source removal ranges from industrial vacuums and compressed air sweeps to hand and power brushes. These instruments and sweeping techniques are used while the ductwork is zoned and under negative pressure. The knowledge gathered during the video inspection allows the project manager to select the most effective methods for duct cleaning and source removal.

WHY IS THE VIDEO INSPECTION NECESSARY?

The answer to the question of the necessity of video inspection is a simple reply, "Source Removal". The typical contaminant (what is typical?...paper lunch bags, coffee cups, cigarette

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packages, tools, sheet metal, torn insulation, duct nails, fasteners, human hair, insect nests, insect bodies, rat droppings, dead birds, tennis balls and microbial growth just to name a few) must be identified. Dust and dirt may be the predominant contaminant. Once the source of the problem is identified, then treatments to prevent the return or reoccurrence of the problem can begin.

Adequate cleaning cannot take place without visual confirmation that the source contaminant has been removed and properly decontaminated.

The primary purpose of the video inspection is confirmation of the problem, identification of the source, determination of the location, and solution to the problem.

The secondary purpose of video inspection is the confirmation of the "source removal" and cleaning services performed restoring the ductwork to "as new" conditions.

EQUIPMENT SPECIFICATIONS

Specification selected -

1) Camera
   Color CCD camera with 300,000 pixel (370 line) horizontal with 5 lux minimum illumination lens view in front of unit; 1 - 15 watt overhead lamp
   12 incandescent bulbs (Variable control)
   Remote focus range 1/2" to infinity
   Single cable operation - 100 feet of cable.
   Camera weight -1lb.
2) Camera Cart
   9" x 7" x 3 1/2" high - weight 4lbs
   Four wheel drive
   Two inch wide pneumatic tires
   One inch under carriage clearance
3) Control Specifications
   On/Off lighting switch
   Variable control adjustment
   Speed control
   Forward, reverse, right turn, left turn toggle switch
   Focus control, near/far
4) Video Recorder and Monitor
   Color 9" wide monitor with video and recorder.
5) Discussion of Equipment-advantages
   A. Color versus black & white
      1.Allows the operator to distinguish different types of contamination in lined and unlined ductwork.
      2. Does not allow confusion from differentiation of sheet metal patterns, seams, overlaps, crevices, etc.
      3. Contamination can be identified by color, intensity, pattern, density and texture.
      4. In lined ductwork, color improves the distinction between the contaminant source and the lining and allows the operator to note stains, which may be moisture or bacterial growth.

   B. Front view lens and stationary camera. This preferred feature allows steady camera viewing and direct line of sight down the duct.

   C. Lamps 15 watt overhead - this feature provides additional lighting down the ductwork to avoid drop downs, and supply plenums.

   D. 12 incandescent bulbs required for adequate lighting with variable light control.

   E. Wide angle lens, with near/ far adjustment, allows interior focus to both near and distant objects.

   F. Single (12 pin) cable; this approach reduces a wire nightmare with less entanglement with duct interior, sheet metal and fasteners. It allows easy installation and setup. The cable is sued to measure distance into the duct, for precise location of the camera.

   G. Four wheel drive - Ductwork can be a treacherous locomotion on all drive wheels. This prevents hang ups and turn overs at various angles in round ductwork.

   H. Turn capabilities, variable lighting, variable speed are control features.

Additional features suggested on new models might be: a level device on the camera (allowing the inspector to focus up and down at a spot location), a stationary probe to disrupt some type of contamination or gather microbial samples, an adjustable wheel level device, and independent 4 wheel suspension for camera stability and to avoid tipping in the ductwork. Further

miniaturization will be useful in some applications for smaller ducts.

METHOD OF OPERATION

Insertion of the camera is accomplished by using an access portal cut near the supply air plenum, however, a properly sized register may offer an entry point). In 80% of the inspections, the majority of the contamination is found within the first 100 feet of supply duct next to the air handler unit. In some cases (approx. 20%) moisture, condensation, dirt in seams, and areas of poor air flow can cause isolated problems further into the duct work.

The air handler is shut down and the camera is placed in the supply duct. The time and recording footage is logged. The power supply cord has 1 foot markings along the cord. Once in the duct, light is adjusted to allow adequate contrast with the background. (Note: Unlined ductwork has a high reflectance in some areas. The lighting adjustment is necessary to differentiate colors and stains. In lined ductwork there is little contrast so higher light intensity is required.)

The camera is driven forward 1-2 feet, and then reversed. The operator observes if there are tire tracks in the duct or lining. In some cases the dirt is pulled away by the tires or supply cord. A notation of approximate depth consistency, color and surface adhesion of the contaminant is logged. The inspection continues through the duct. Focus and lighting is adjusted for long viewing. As areas of interest are noted, closeup views are accomplished by driving to the area in question. Lights and focus are adjusted to get the best picture. The location and photo journal are logged. This process is repeated until the operator can go no further and the unit is extracted. The cameral is turned 180° degrees and driven back allowing a reverse angle of points of concern on the photo journal. A full video (one to two hours actual camera time) may take up to 8 hours for a 25,000 square foot building.

Description of Video Inspection Results

Before we can review the video, a definition is required concerning one very important criteria. What is the definition of "normal clean/healthy ductwork"? Should one define the best conditions as "As New"? Videos of "New Ductwork" have revealed mounds of construction dust, plaster, outside dirt and mud. Contaminants include manufacturing oils, duct sealants, remnants of duct nails, tapes, shaping and liners. The inspectors have shown lunch sacks, lost tools, watches and wallets (no money, just the wallet). Certainly many of these conditions and objects would not be considered normal, clean or healthy.

Under the definition "As New" conditions, the system should be run for an adjustment period. The operator will need to "burn in" the system, change filters regularly, listen carefully for suspicious noise or odors and wait for the system to self adjust. This may be the alternate base line we are searching for as a better definition.

We have video inspections of new systems one year to 18 months in age. The systems contained high microbial contamination, dust and dirt. The air handlers were clogged with dirt, human hair and torn insulation. In comparison are two videos of systems that are 15 years old. In one system the video camera has actually become stuck in the contamination. In another system the ductwork is shiny and has only a fine layer of silt. The main difference is scheduled changing of filters, a coil cleaning maintenance between the unit area, and good house-keeping practices. Certainly the age of the system has no bearing on the condition of the duct.

Several classifications of contamination can be recognized:

A) Particulate

1. Outside dirt - granular; brown, red, or gray in color; large particle size; localized to the bottoms of the ductwork or dead area, corners, or low air velocity turns.
2. Rust - flaky; orange/red large particles to fine powder; areas around coils, fans, chillers, pans; stains in the ductwork.
3. Fibrous matter - long fibers; ceiling tiles; duct liner; human hair; yellow, pink, black, and gray filter media. Normally found in coils, diffusers, turn vanes, reheaters.
4. "Parts" - insect parts; duct sealant; embrittled coatings, broken off nails, and tape; black or dark brown grit. Found in low volume air areas, normally on the bottom of the duct.

B) Chemical Contamination

1. Black soot - a mixture of oily black hydrocarbons; black to dark brown in color. Normally found on sides and top of

the duct work, around diffusers, and in outside supply air.

2. Tobacco Smoke - brownish grey in color, normally attached to sides and upper duct. Found on return air supply and registers.

3. Industrial Pollutants - oils, hydrocarbon fumes, cooking fumes, cleaning chemical fumes; black to white in color. Found on sides and tops of ductwork, supply diffusers, and return registers.

C) Microbial Contamination

1. Active state, moist growth, slime; multicolored, red, yellow, green, brown, black. Located in coils, chillers, fans, drain pans, duct seems, low duct areas, any areas where this is a combination of dirt and moisture.

2. Inactive spore state, dry stains; multicolored powder; white, yellow, orange, red. Found on coils, drain pans, upper ductwork.

Source identification allows the project manager to determine the best cleaning techniques, equipment and proximity of direct access to the contaminant. For example, in the case of severe microbial growth, the project manager may wish to zone off an area, fog with a biocide, scrape, wash with a germicide, apply a sealant and fog again prior to returning to operation.

ADVANTAGES IN TECHNOLOGY

The key advantages to video inspection are:

1. Health and safety of the maintenance service employees and building occupants. Once source identification has occurred it can be properly dealt with. Microbial sources are the most dangerous. Dust and dirt are a nuisance on the desk tops.
2. Tactics and techniques - The project manager has several different equipment technologies to use to remove the contaminants. An air sweep can be employed against dirt, but, proves useless against rust. Power brushes can be applied to rust but are devastating to sound insulation. Knowledge of the interior conditions is important.
3. After source removal, you have a video record of the decontaminated area; conditions prior to the service, and after final inspection and approval.

APPLICATION OF THE INSPECTION TECHNIQUES

A good inspection is all that you may ever need!

The focus of this paper is the identification of contamination. In the cases discussed, the video has located a source of complaint. However, some videos find nothing. Some of the building owners and managers are aware that local, state and federal IAQ standards are coming. Some owners, with competition for office space, wish to avoid the suspicion that the work place may be contaminated or unhealthy. Their need for an inspection is positive. They start an IAQ base line file, and request an annual update and inspection of the entire air conveyance system. By doing so, they avoid one of the major areas of litigation, "gross negligence". By keeping a file, establishing a maintenance program, and completing an annual IAQ audit, they are not only proving concern for the occupants, they are providing a shield of legal protection against a claim of gross negligence.

Annual updates can save money in terms of catching problems ahead of time and before they become larger problems. The building management can document the effectiveness of their maintenance program.

If a "Source Removal" project is required the results are verifiable. Continued inspection limits the liabilities and provides evidence that the source has been removed. If contamination does return, it can be dealt with on a timely basis and further searches for the "source" initiated until the condition is arrested.

The final result of a Video Inspection is that everyone; management, owners, and occupants, should all breathe a little easier.