

This management practice Guidance Note is jointly prepared by Asian Institute of Intelligent Buildings (AIIB), the Hong Kong Air Conditioning and Refrigeration Association Ltd., (ACRA), Building Services Operation and Maintenance Executives Society (BSOMES), and Hong Kong Building Commissioning Centre (HKBCxC).

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Disclaimer

This Guidance Note is issued for the industry to use and act as a guideline to help persons practicing in this field of “Air Duct Cleaning”. It is the intention of the four co-operating institutions which are non-profit making to work together for the benefit of the related industry. The Guidance Note is for reference only. The institutions that prepared for the Guidance Note will not take any responsibility arising from the use of it and any damages caused.

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1. Introduction

- 1.1 The Guidance Note (hereinafter referred to as GN) provides a practical guidance on the subject of Air Duct Cleaning. This GN is prepared for building owners, building tenants, air duct installation contractors, building managers, and those related to the design, operation and maintenance of air duct systems.
- 1.2 The advice recommended by this GN may not be exhaustive. It should be read in conjunction with other international standards and publications in order to provide the best practice.
- 1.3 To start with, this GN gives both an overview of the Hong Kong practice on air duct cleaning and an overview of the international practices on air duct cleaning. The international practices and standards are mainly based on Europe, Asia, USA and UK. Having reviewed the practices locally and internationally, the GN recommends a practical approach for dealing with air duct cleaning on the following aspects:
- ✧ Recommended air duct cleaning frequency for projects to be handing over to client;
 - ✧ Recommended standards for air duct cleaning;
 - ✧ Recommended treatment for control of microbial contamination;
 - ✧ Recommended monitoring criteria of dust inside air duct as a signal for duct cleaning; and
 - ✧ Recommended air duct cleaning frequency for new projects and projects under operation and maintenance.
- 1.4 The air duct cleaning recommendation is primarily based on the application to metal air ducts without internal insulation and lining. This is referred to as “non-porous air duct” throughout this GN.
- 1.5 Porous air duct will not be considered in this GN. For the most comprehensive information for porous air duct, NAIMA’s publication of “Cleaning Fibrous Glass Insulated Air Duct Systems Recommended Practice” [1] should be referred.

2. Interpretations

2.1 Air Duct

A passageway for distribution and extraction of air, excluding plenums. (From ASHRAE)

2.2 Access Door

Fabricated metal barrier (hatch) by which a service opening is accessed or closed.

2.3 Biological Contaminants

Bacteria, fungi (mold and mildew), viruses, animal dander, mites, insects, pollen, and the by-products of these elements.

2.4 Cleaning

To rid of dirt, impurities and extraneous matter,

2.5 Contaminant

Any substance not intended to be present that is located within the air duct system.

2.6 Inspection

A critical appraisal in which the system, or representative portions thereof, are viewed closely.

2.7 NADCA

National Air Duct Cleaners Association.

2.8 NAIMA

North American Insulation Manufacturers Association.

2.9 Non-porous Air Duct Surface

Any surface of the air duct system that cannot be penetrated by water and air, such as sheet metal, aluminum foil, or polymeric film used to line flexible duct.

2.10 Porous Air Duct Surface

Any surface of the air duct system that is capable of penetration by

water and air, such as glass duct liner, fibre glass duct board, wood and concrete.

2.11 Recommendation

Suggested practice, which is not mandatory for compliance with the standard.

2.12 Visual Inspection

Visual examination with naked eye of the cleanliness.

3. Background / Experience

Common to all air duct systems in the world, maintaining clean ventilation and air-conditioning systems is an important part of sustaining acceptable indoor air quality (IAQ). When an air duct system is a source which contaminants are introduced into an occupied space, properly performed air duct cleaning should take place to reduce or eliminate contaminant introduction.

Contaminants in air duct system can take many forms, including a number of common types such as dust particles, mold spores, debris, man-made vitreous fibres and other items. Biological contaminants may include bacteria, fungi (mold and mildew), viruses, animal dander, mites, insects, pollen, and the by-products of these elements.

Up till now, although there are no direct legal provisions on maintaining a certain standards of IAQ and air duct cleanliness, there are increasing awareness and concerns from the public on the health issue for every occupant regarding clean ventilation and air-conditioning air duct system, especially after the SARS outbreak in March 2003. The Occupational Safety and Health Ordinance, CAP 509 is regarded as the most relevant legislation in relation to this issue. All employers have to fulfill general duties and they must, as far as reasonably practicable, ensure the safety and health of all his employees at work.

Experience has indicated that very few air duct systems are spotlessly clean. After the air duct system is installed and is operating, the contamination process will continue throughout the life of the system. Low efficiency air filtration, air bypass, lack of an inspection programme, humid conditions, and many other factors can result in severely contaminated air duct system.

In this GN, one clear recommendation is to institute a periodic inspection programme that serves to determine the need for air duct cleaning. The acceptance level of cleanliness after cleaning shall also be recommended. This GN adopts only objective criteria. Non-scientific or personal judgments are intentionally not preferable.

4. Overview on International Practices

These are the frequently asked questions on air duct cleaning:

- When do we need to clean the air ducts?
- How do we clean the air ducts and what standards should be followed?
- How do we determine whether the air duct after cleaning is acceptable?

Several organizations around the world dedicate all or a portion of their efforts toward air duct cleaning. Currently, Japan, Singapore, USA, Sweden and United Kingdom are the countries that have issued publications and research reports on the subject of air duct cleaning.

4.1 Sweden

In Sweden, the Swedish National Board of Housing, Building and Planning issued General Guidelines in 1992. It indicates the checking of the performance of ventilation systems for local practice.

4.2 Japan

In Japan, the Ministry of Health and Welfare issues the Laws for Maintenance and sanitation in Buildings 1970. Also, an organization called “Japan Air Duct Cleaners Association (JADCA)” issued standards and report for local practice.

4.3 Singapore

In Singapore, the Guidelines for Good Indoor Air Quality in Office Premises (1996) was issued by the Institute of Environmental Epidemiology, Ministry of Environment. Several points relating to duct cleanings are:

- Cleaning of windows, doors, floors and other surfaces in contact with supply air.
- The entire ACMV system should be cleared of dirt and cleaned before operation starts.
- Regular inspection, cleaning and audit on air systems and components.

4.4 United Kingdom

In the United Kingdom, there is no direct legislation on the issue of air duct cleaning. The Health and Safety Work Act, Workplace (Health and Safety Welfare) Regulation states that employers and occupiers have the responsibility to maintain a healthy workplace for employees. Therefore, a clean working environment is required and a duty to clean “as appropriate”. For developed countries like U.K., there have been a number of important and outstanding publications on the subject.

The Building Services Research and Information Association (BSRIA), a research institute, issued a Standard Specification for Ventilation Hygiene: 2002, [2]. Some important points are:

- Inspection protocol shall be agreed
- Level of cleanliness shall be defined in tender
- Cleaning method statement shall be submitted
- Cleaning methods : manual vacuum, hand wipe, steam wash, chemical spray, mechanical brush, air jet, air blasting,
- Disinfection as per the Control of Substance Hazardous to Health Regulations (COSHH) 1991
- Report after cleaning

The Chartered Institution of Building Services Engineers (CIBSE) issued a document called Hygiene Maintenance of Office Ventilation Ductwork TM 26: 2000, [3]. The document is very specific on the subject of air duct cleaning. In particular, the followings are extracted:

- Ductwork Hygiene Indicator
- Clean Air Distribution Ductwork

- Protocol for Surface Sampling
- Sampling Results

The Heating and Ventilating Contractors' Association (HVCA) issued a very important document called Guide to Good Practice Cleanliness of Ventilation Systems TR/17 2002, [4]. It is the most practical and qualitative guide providing objective criteria on the following main topics:

- Inspection/Monitoring on System Testing
- Cleaning Methods
- Verification of Cleanliness
- Specific Consideration of Kitchen Extract Systems
- Health and Safety
- Microbiological Contamination

The main ideas from TR/17 on the objective judgments on air duct cleaning will be adopted to form the basis of this GN.

4.5 United States

In the United States, NADCA is the leader of reference. NADCA publishes many documents and the most important ones are:

- ✧ ACR 2002, Assessment, Cleaning, & Restoration of HVAC Systems, [5].
- ✧ NADCA General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems, [6].
- ✧ Understanding Microbial Contamination in HVAC Systems [7]

There are also other useful publications relating to the subject and they can be found in the section of Bibliographies.

The NADCA publications cover a lot of broad issues on the topics. However, some criteria rely on personal judgment by visual inspection. There are a lot of treasure experiences from the NADCA publications.

5. Overview on Hong Kong Practice

The air duct cleaning work in Hong Kong has not been extensively carried out especially in the commercial sector. It is not difficult to understand that the cost of the work is of major concern. However, there are in fact requirements on this topic in the Government departments.

5.1 Architectural Services Department

The General Specification of Air-conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Buildings in 2001 [8] states the requirements on Indoor Air Quality (IAQ) and “Air Duct Cleaning Points”.

- In [8], section A5 IAQ, sub-section A5.7 IAQ Assessment and Methodologies and sub-section A9.19 IAQ Equipment and System Testing indicate the requirement on IAQ measurement as:
 - ◆ First assessment – after testing & commissioning,
 - ◆ Second assessment – 6 months after occupation of building or substantial completion,
 - ◆ Third assessment – 2 months before the end of maintenance period.

- In [8], section B2 Ductwork, and sub-section B2.9 Air Duct Cleaning Points indicates the requirements of air duct cleaning on maximum distance of 4m between 2 points, sleeves, access panels, disinfection agent and cleaning tools, etc.

The above requirements are for new projects only. From the General Specification [8], section B2.9 is the only requirement on the subject from the Government. However, the implementation of air duct cleaning has to be specified in the Particular Specification for each contract.

For operation and maintenance, there is no specific guideline.

5.2 Environmental Protection Department

The Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places issued in 2003 [9] has a sub-section 4.4.2.4 Duct Cleaning under Section 4 - Strategies to Achieve IAQ Objective. In this document, it states that the NADCA standard of using a vacuum test to measure the results of duct cleaning. The standard specifies a maximum surface debris loading of 1 mg / 100 cm² (i.e. 0.1 g/m²) on non-porous system components after completion of a duct cleaning job.

In addition, it also states some principles relating to air flow, vacuum equipment, access holes, etc.

5.3 Non-government Large Private Sectors

Although some private sectors have no requirements on air duct cleaning in both new projects and maintenance jobs, some large private sectors in Hong Kong, particularly in new projects, do request for specified requirements on air duct cleaning. Some of the extracted requirements are:

- Frequency of air duct cleaning:
 - ◆ First time – before operation of system,
 - ◆ Second time – 1 month before completion of maintenance period.

- NADCA standards to be adopted.

6. Recommended Management Practice

Air duct cleaning which contributes to the success of IAQ has been well recognized locally and internationally. Recommendations over management practice in Hong Kong to deal with air duct cleaning is therefore of great value for the HVAC industry in both new projects and maintenance jobs.

For new projects, the frequency of air duct cleaning is recommended as:

- 1st Time : Before operation of system,
- 2nd Time: 1 month before completion of maintenance period.

For operation and maintenance of air duct systems, the following practice is recommended. The management practice focuses on the process from the point of view of a building maintenance manager. This practice applies only to non-porous air ducts and kitchen extract air ducts. It is recognized that the process can be divided into 4 stages.

Stage 1: Inspection

Stage 2: Cleaning

Stage 3: Verification of Cleanliness

Stage 4: Surface Treatment

6.1 Non-porous Air Duct

This section recommends the management practice only for non-porous air ducts, except for kitchen extract air system which is to be recommended in the Section 6.2. For porous air ducts, the management practice will be different and is beyond the scope of this GN.

6.1.1 Inspection

NADCA Standard ACR 2002 [5] recommends a minimum inspection interval for different building usage classifications. To suit the Hong Kong situation, Table 1 indicates a recommended air duct inspection interval. This table is modified from NADCA and is suitable for practice in Hong Kong. However, the need for more frequent cleanliness inspection is subject to numerous environmental, mechanical and human influences.

Table 1 – HVAC Cleanliness Inspection Schedule

(Recommended Minimum Inspection Intervals)

Building Use Classification	Air Handling Unit	All Ductwork
Type I, (a) Food & Beverages (b) Healthcare	1 year	1-2 years
Type II, (a) Residential (b) Commercial	1 year	2-3 years

With reference to HVCA TR/17 [4], an objective method of testing the “air duct surface condition” has to be adopted for determining when an air duct system is considered dirty for appropriate cleaning. Two alternative testing methods are recommended.

- ◆ Deposit Thickness Test (DTT)
- ◆ Vacuum Test (VT)

The DTT method determines the mean surface deposit in terms of micron thickness, whereas the VT method determines the mean deposit weight in grams per m². Table 2 indicates the “Surface Deposit Limits” as the criteria on the need for air duct cleaning. If the test result exceeds the tolerable limits, air duct cleaning work is to be considered. The limits are based on current good practice. These methods take away the subjectivity of a visual inspection and therefore are recommended. Above these limits, the system would appear to be dirty.

Table 2 – Surface Deposit Limits

System Type	Surface Contaminant Limits	Test Method
Extract	6g/m ² (i.e. 60mg/100cm ²) 180 µm	VT DTT
Recirculation & Supply	1g/m ² (i.e. 10mg/100cm ²) 60 µm	VT DTT

The instrument to be used for DTT is an electromagnetic induction type thickness gauge with statistics and a non-contact measuring tip. The photo is given in the Section 10: P1.

For VT, an air sampling pump capable of drawing 10 litres per minute through a cassette containing 37mm matched weight filter is to be used. The details of the testing method can be found in the Appendix D – Testing Methods of HVCA TR/17 [4]. The photo is given in the Section 10: P2.

Without the use of equipment, VT can also be carried out by an equivalent method. It is referred to the average weight of dust inside an air duct within a sampling area of 10 cm by 10 cm.

6.1.2 Cleaning

Having inspected and obtained the test results, management shall consider the arrangement of cleaning work from contractors. It is recommended that the contractors follow closely with the cleaning methods, either in NADCA Standard ACR 2002 [5] or HVCA TR/17 Second Edition 2002 [4].

For details of the cleaning procedures and specifications such as the preparation, protection, safety and health, methodology, equipment, access, reports, etc., the NADCA General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems [6] and the Standard Specification for Ventilation Hygiene by BSRIA [2] should be referred.

For protection of workers during the course of dusting and related cleaning in air ducts, safety and health provisions should be provided. For detailed management, NADCA Guide to Safety & Loss Control [10] should be referred.

6.1.3 Verification for Cleanliness

Again, in order to avoid the subjectivity of visual verification, an objective test has to be conducted. Recommended by NADCA, a vacuum test (VT) as indicated in section 6.1.1 above will be used with the acceptance criteria as:

- ◆ Not more than $0.075\text{g} / \text{m}^2$ (i.e. $0.75\text{ mg}/100\text{cm}^2$).

6.1.4 Surface Treatment

A surface treatment is a chemical product applied to an interior surface of an air duct system. Anti-microbial materials such as sanitizers and disinfectants are products designed to control microbial contamination. Surface treatment is optional and depends on experience and general practice of each application.

It should be noted that only the internationally approved type which contains no harm to human health could be applied.

6.2 Kitchen Extract Air Duct

This section recommends the management practice for kitchen extract air ducts. Kitchen extract systems are liable to internal fouling by grease and oils. Grease deposits within systems also pose hygiene, odour, vermin and mechanical efficiency hazards. As the usage of kitchen extract system determines the requirement for cleaning, the criteria are very different from the non-porous air duct system.

6.2.1 Inspection

HVCA TR/17 [4] recommends an inspection interval of not exceeding 12 months. For measuring grease deposits, a Wet Film Thickness Test (WFTT) measurement method is recommended. Alternatively, the Deposit Thickness Test (DTT) may also be used. The DTT is however less reliable for soft or liquid deposits. The details of the WFTT testing method can be found in the Appendix D – Testing Methods of HVCA TR/17 [4]. Table 3 Surface Grease Deposit Limits indicates the criteria of cleaning required.

Table 3 – Surface Grease Deposit Limits

Wet Film Thickness Test (WFTT) Measurement	Recommended Action
200 µm as a mean across the system	Complete cleaning required
Any single measurement above 500 µm	Urgent local cleaning required

It is well understood from the industry that most kitchen extract air system will undergo regular cleaning from time to time. Being practical, it is not necessary to go through the stage of inspection before cleaning.

The GN only considers the above objective inspection method as a qualitative guideline. The requirement for cleaning will be based on experience in maintenance. From TR/17 [4], a recommended Table 4 – Frequency of Cleaning is provided as a reference from past experience.

Table 4 – Frequency of Cleaning Kitchen Extract System

Heavy Use	12-16 hours per day	3 monthly
Moderate Use	6-12 hours per day	6 monthly
Light Use	2-6 hours per day	12 monthly

6.2.2 Cleaning

Based on experience or the objective method proposed above, cleaning work will proceed. For details of the cleaning procedures and specifications such as the preparation, protection, safety and health, methodology, equipment, access, reports, etc., the Guide to Good Practice Cleanliness of Ventilation Systems TR/17 2002 [4] from HVCA and NADCA standards should be referred.

Similar to cleaning non-porous air ducts, protection of workers during the course of dust and related cleaning in air ducts, safety and health provisions should be provided. For detailed management, NADCA Guide to Safety & Loss Control [10] should be referred.

6.2.3 Verification for Cleanliness

Again, for the purpose of avoiding the subjectivity of visual verification, an objective test has to be conducted. Recommended by HVCA TR/17, the Deposit Thickness Test (DTT) or Wet Film Thickness Test (WFTT) as indicated in section 6.2.1 above will be used with the acceptance criteria as:

- ◆ No single measurement exceeds 50 µm.

6.2.4 Surface Treatment

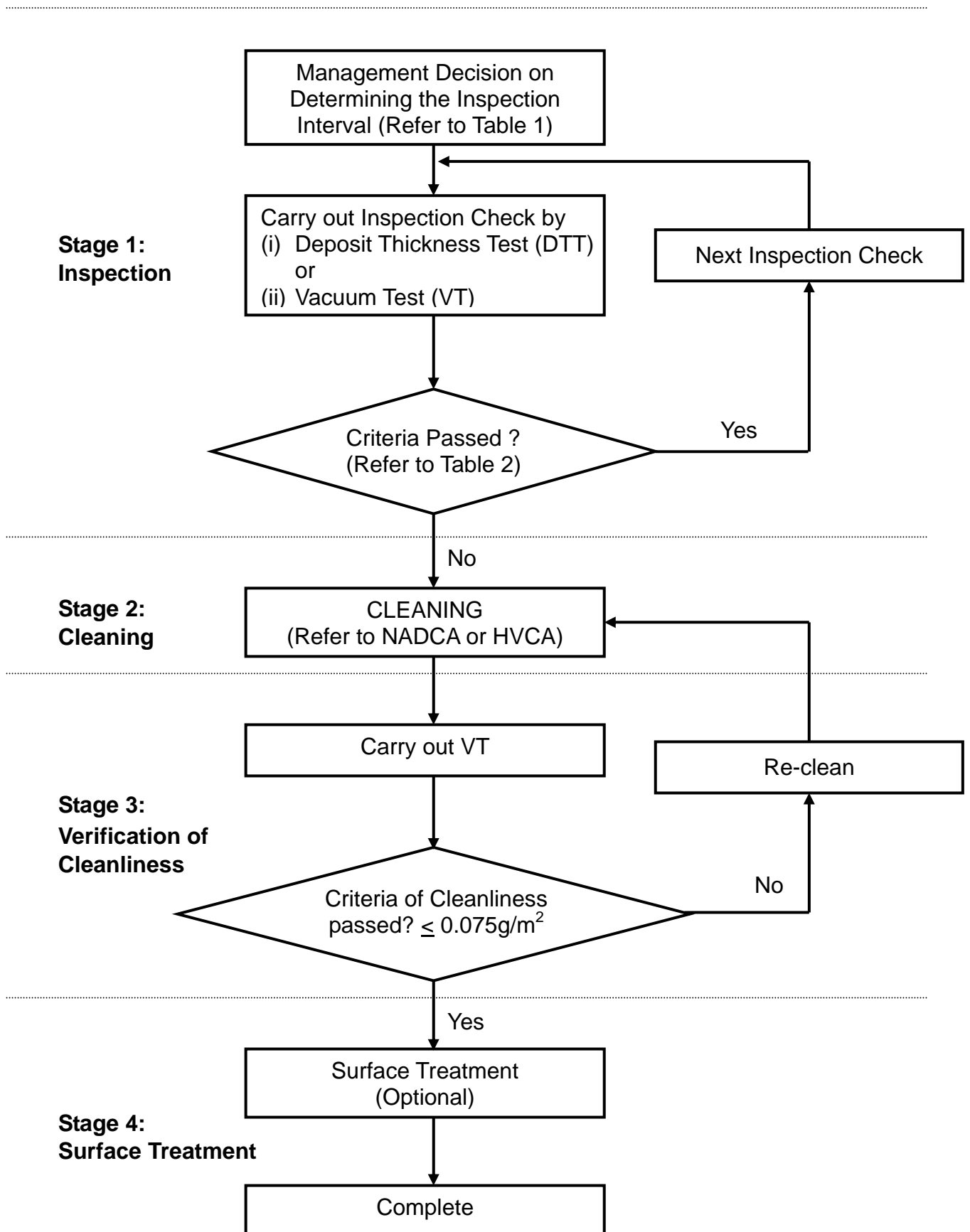
A surface treatment for kitchen extract system may not be necessary and the application is subject to individual practice.

7. Quick Guide

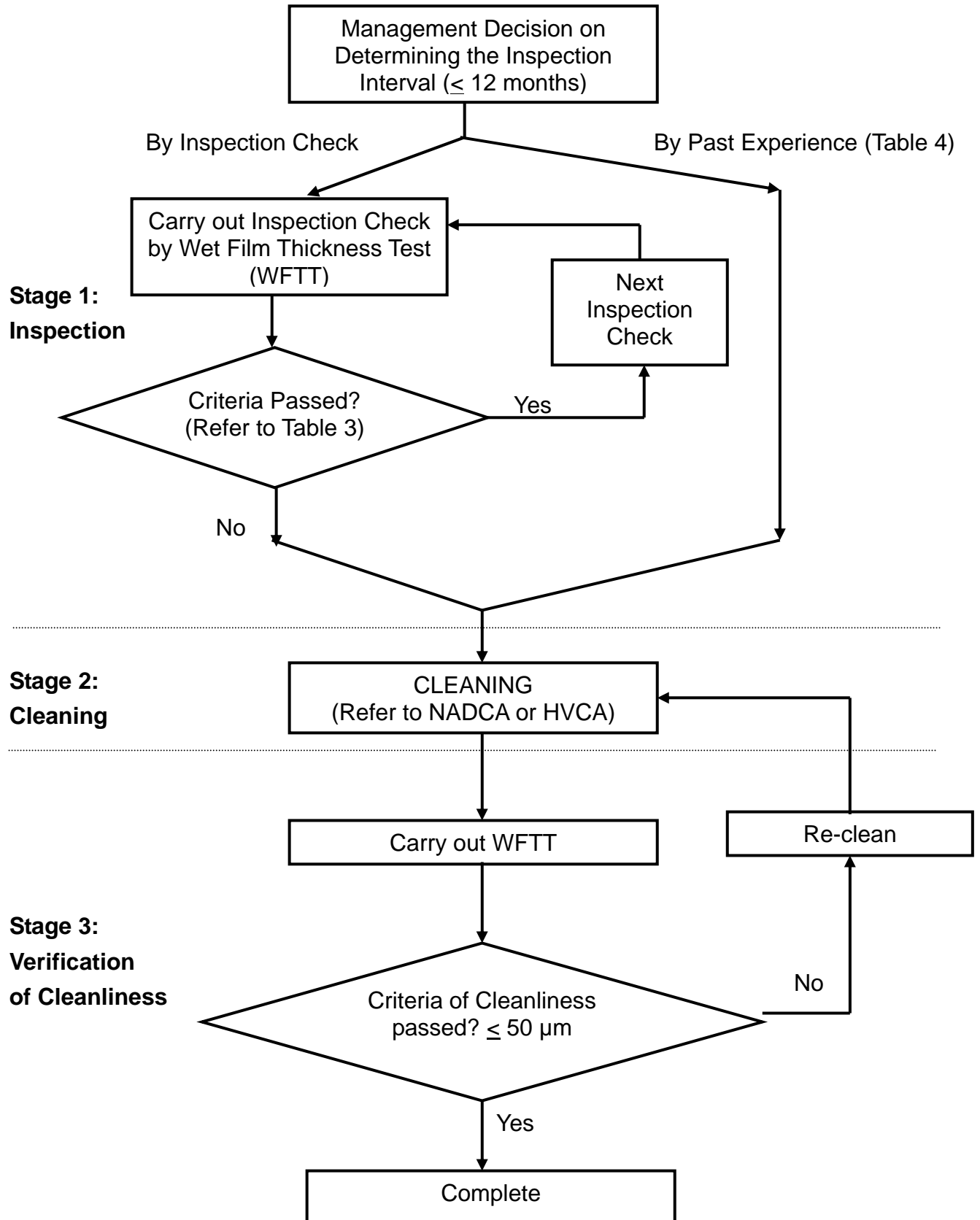
To enable a clear and simplified use of the recommended practice, a quick guide in the form of flow chart is given:

- ✧ F1 - Air Duct Cleaning Management Practice for Non-porous Air Duct
- ✧ F2 - Air Duct Cleaning Management Practice for Kitchen Extract Air Duct

F1 – Air Duct Cleaning Management Practice for Non-porous Air Duct



F2 – Air Duct Cleaning Management Practice for Kitchen Extract Air Duct



8. Bibliographies

- [1] NAIMA, "Cleaning Fibrous Glass Insulated Air Duct Systems Recommended Practice", 1993.
- [2] S. R. Loyd, the Building Services Research and Information Association (BSRIA), "Standard Specification for Ventilation Hygiene", 2002.
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- [5] NADCA, "ACR 2002, Assessment, Cleaning, & Restoration of HVAC Systems".
- [6] NADCA, "General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems".
- [7] NADCA, "Understanding Microbial Contamination in HVAC Systems".
- [8] The General Specification of Air-conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Buildings in 2001.
- [9] The Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places issued in 2003.
- [10] NADCA, "NADCA Guide to Safety & Loss Control", 1999.

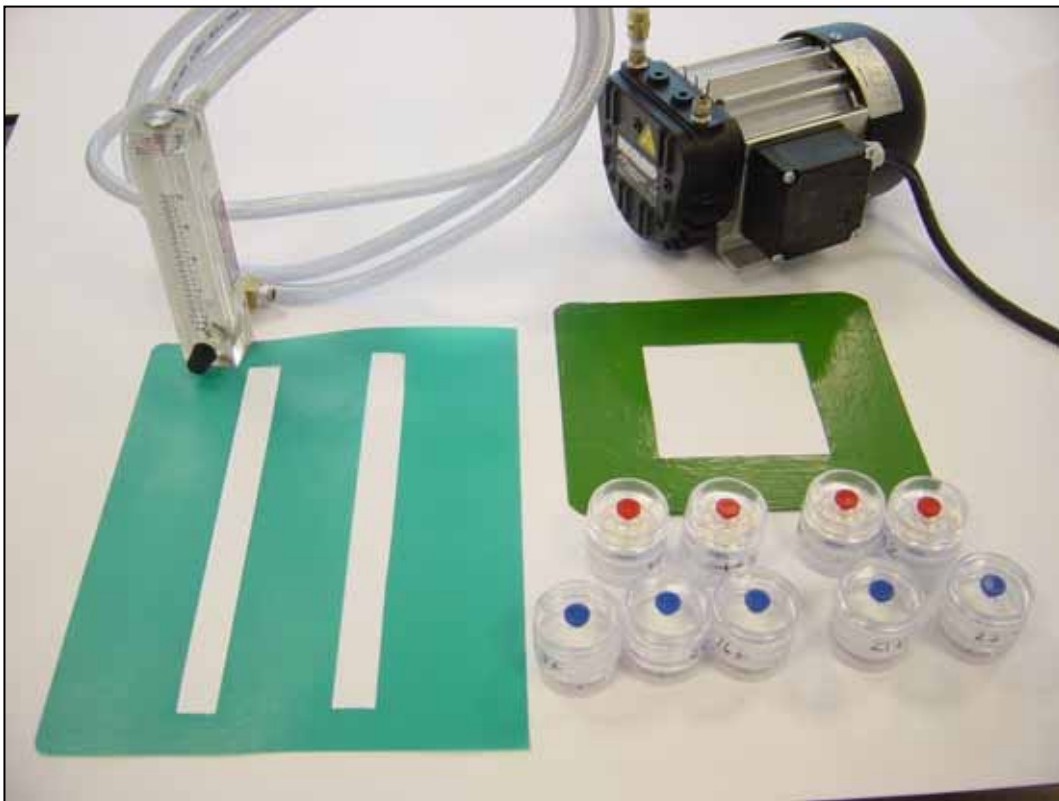
9. Other References

- NADCA, Introduction to HVAC System Cleaning Services, A Guideline for Commercial Consumers, 2002.
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- Robert W. Tinsley, "Ductwork system Cleaning 101", HPAC Engineering, July 2003.
- S. R. Loyd, the Building Services Research and Information Association (BSRIA), "Guidance to Standard Specification for Ventilation Hygiene", 2002.
- Sheet Metal and Air Conditioning Contractors' (SMACNA), "Duct Cleanliness for New Construction", 2000.

10. Photos



P1: Kit for Deposit Thickness Test (DTT)



P2: Vacuum Test (VT) – Pump & Accessories