



Total E&P UK Ltd

**Leisure Centre
Westhill
Aberdeen**



INTERNAL AIR QUALITY

HVAC Condition Audit and Air Quality Report

June 2019

CONTENTS

- 1.0 INTRODUCTION
- 2.0 SYSTEM CONDITION REPORTS
- 3.0 LABORATORY ANALYSIS
- 4.0 OCCUPIED SPACE CONDITIONS
- 5.0 RECOMMENDATIONS SUMMARY

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INTRODUCTION

This document describes the findings of an Internal Air Quality (IAQ) assessment and HVAC condition audit, which forms part of an ongoing IAQ monitoring programme implemented for Richard Irvin at Total E & P UK Ltd's Leisure Centre in Westhill, Aberdeen. The tests and inspections reported in this document were carried out by Westfield Caledonian's Technical Manager, John Bryson, on 26th June 2019.

The purpose of the programme is to both assess the health risk presented to building occupants by quantifying the air quality to which they are exposed, and to assess the risk of air quality deterioration by inspecting and testing the HVAC systems supplying the occupied areas. The audits comprising the programme include a visual inspection of the air handling plant and distribution systems, retrieval of samples to determine the level of particulate and microbiological contamination present within the systems, together with an assessment of their mode of operation. Additionally, the air quality and environmental comfort conditions to which the building occupants are exposed is quantified by carrying out a series of tests to determine recognised internal air quality and comfort parameters.

The motivation for implementing this programme derives from Total E&P UK Ltd's desire to ensure the health and wellbeing of employees and visitors to these premises is not compromised by the internal environment of the building. The documentation also demonstrates the measures taken to comply with their obligations under regulations 5 and 6 Workplace (Health, Safety and Welfare) Regulations 1992, and fulfils their obligation of Risk Assessment placed upon them by regulation 3 of the Management of Health and Safety at Work Regulations 1999.

This document contains detailed descriptive reports of plant and system inspections, together with the results of a series of tests carried out throughout the building to quantify the air quality and environmental conditions present at the time of the audit. All observations, findings and results are assessed and analysed within the main body of this report, together with any recommendations which may be derived from these observations.

SYSTEM CONDITION REPORTS

Air Handling Unit No.3 – General Areas

System Description

Fresh air is drawn into the unit through an external high level weather louvre, before being passed through two stages of filtration comprising low efficiency cartridge-type pre-filters followed by medium efficiency bag filters. The air then passes through a heater battery and a recuperator, whose purpose is to retrieve waste heat from the air exhausted from the occupied areas, before being distributed by means of a single centrifugal fan through a system of spirally wound circular ductwork. The areas supplied are the general purpose areas within the main Sports Centre.

Fresh Air Intake

It was not possible to inspect the weather louvres due to access restrictions, and access to the internal components of the intake ducting was also severely restricted. It is recommended that additional access is provided to facilitate proper inspection and testing, together with necessary hygienic maintenance activities. In this latter respect all horizontal surfaces were noted to be subject to a moderate deposit of particulate, suggesting an unsatisfactory hygienic condition, which was confirmed by the laboratory analysis of the bacteria and fungi samples retrieved from this area. When access is achieved, all surfaces should be cleaned.

Filter Section

Both the primary and secondary filter media was found to be fairly heavily laden, and the absence of appropriate sealing strips at the cartridge perimeters is considered to be resulting in a higher than necessary proportion of unfiltered air bypass. It was also noted that the secondary bag filters were installed with the pockets in the horizontal orientation, which severely restricts the cross sectional area of filter media through which air is allowed to pass. Where possible, filters such as this should be installed with the pockets in the vertical orientation, to allow full inflation of the filter pockets.

Conditioning Sections

Both the heater battery and recuperator components were found to be in good mechanical and hygienic condition, with only light mechanical damage on the upstream face of the battery noted, and light particulate deposit on all other surfaces.

SYSTEM CONDITION REPORTS

No specific recommendations are made therefore in respect of the condition of these components, other than to ensure that vacuum brushing of heat transfer fins and interstices is carried out as a regular planned maintenance activity.

Fan Section

Although there was no evidence of excessive grease deposit on or around the fan components, significant impacted carbonaceous particulate was noted on the fan impellers. It is important that these components are maintained in a good hygienic condition, and it is recommended that all surfaces are regularly wiped down as part of a planned hygienic maintenance programme.

Distribution Ducting

Again, access to the distribution ducting was fairly limited, but sufficient to ascertain that particulate deposit was relatively light in the plantroom sections. Microbiological activity was also found to be relatively light, and no recommendations are made at this stage in respect of the hygienic condition of the distribution ducting.

SYSTEM CONDITION REPORTS



No Access to F/A Ducting Severely Restricting Opportunity for Inspection and Test, or The Implementation of Hygienic Maintenance



Moderate to Heavy Particulate Deposit on Horizontal Surfaces of Fresh Air Intake Ducting

SYSTEM CONDITION REPORTS



Moderate to Heavy Load on Pre-filter Media Noted



Moderate to Heavy Particulate Load on Secondary Filter Media Noted

SYSTEM CONDITION REPORTS



Bag Filter Media Incorrectly Installed – Pockets Should Have a Vertical Orientation



Light Particulate Deposit Noted on Floor of Conditioning Sections

SYSTEM CONDITION REPORTS



Good Mechanical and Hygienic Condition of Upstream Face of Recuperator Components



Good Hygienic Condition With Minimal Particulate Deposit Noted Within Conditioning Section

SYSTEM CONDITION REPORTS



Minimal Mechanical Damage Only Noted on Upstream Face of Battery Heat Transfer Fins



Light Particulate Deposit Noted at Fan Inlet

SYSTEM CONDITION REPORTS



Impacted Carbonaceous Dirt Deposit Observed on Fan Impellor Blades



Exhaust Air Side of Recuperator Also Found to be in Good Hygienic and Physical Condition

SYSTEM CONDITION REPORTS



Minimal Particulate Deposit Noted on Internal Surfaces of Distribution Ducting



Good Condition of Internal Components of Distribution Ducting

SYSTEM CONDITION REPORTS



Sample Retrieval from Distribution Ducting Confirming Particulate Deposit to be Light

LABORATORY ANALYSIS

Summary of Analysis

Particulate Contamination

With the exception of the fresh air intake ducting particulate contamination was found to be relatively light through all components of the air handling unit and the accessed portion of the distribution ducting. Although a recommendation is made to ensure that wiping down all internal surfaces is carried out as a regular planned maintenance activity, no immediate specific remedial actions are required, other than in respect of the fresh air intake. Heavy particulate deposit was observed throughout the fresh air intake ducting, and it was noted that there was no access provided to this duct section. Given that these components can only deteriorate in respect of hygienic condition, it is recommended that appropriate access is installed, and that regular hygienic maintenance activities are carried out.

Microbiological Contamination

Microbiological activity in all components of the air handling unit and the section of distribution ducting which was accessed, was found to be satisfactory, with the exception of the fresh air intake duct sample, which returned “Overgrown” results for both the bacteriological and fungal laboratory examination. As described above, additional access requires to be installed to this duct section to facilitate hygienic maintenance activities.

The Chartered Institute for Building Services Engineer has published guidance with respect to the classification of surface sampling microbial results. For the agar plate size Westfield Caledonian utilise in this process, these equate to the following;

Category	CFUs per Plate
Low	<25
Medium	25-45
High	>45

LABORATORY ANALYSIS

Air Handling Unit No.3 – General Areas

Location	Particulate Wipes			Bacteria	Fungi	Bacteria Species	Fungi Species
	Main Contam.	Trace Contam.	Rating	cfu/plate	cfu/plate		
AHU Inlet	80% Crystalline, 20% Carbonaceous	Insect Carcasses	Moderate/ Heavy	>1000	>1000	Not Specified	Mixed Fungal Species
After Filters	100% Crystalline	Man-made Fibres	Light/ Moderate	15	1	Mixed Bacillus	Aspergillus
After Recuperator	80% Crystalline, 20% Carbonaceous	Man-made Fibres, Metal Oxide	Light/ Moderate	26	6	Mixed Bacillus	Mixed Aspergillus
Fan Inlet	20% Crystalline, 80% Carbonaceous	Man-made Fibres	Light/ Moderate	3	1	Staphylococcus	Aspergillus
Distribution Ducting	20% Crystalline, 80% Carbonaceous	Man-made Fibres	Light	8	21	Staphylococcus Bacillus	Mixed Aspergillus

OCCUPIED SPACE CONDITIONS

TEST: Airborne particle count

OBJECTIVES: To assess the degree of airborne dust in the occupied space, by measuring representative particle sizes

METHOD: Handilaz portable laser particle counter

RESULTS:

<u>Location No.</u>	<u>Occupancy</u>	<u>Location</u>	No. of particles per cubic metre greater than or equal to	
			<u>0.5µm</u>	<u>5.0µm</u>
1	0%	Locker Corridor	5.78x10 ⁵	1.85x10 ⁴
2	Just after full class	GP Room	4.53x10 ⁵	1.61x10 ⁴
		Recommended Upper Limit:	3.5x10⁶	2.9x10⁴
		<i>External</i>		

Results above the recommended limit are shown in bold

OCCUPIED SPACE CONDITIONS

Airborne Dust Levels

Westfield Caledonian recommend target maximum airborne dust levels of 3.5×10^6 particles per cubic metre at a particle size of 0.5 microns or greater, and 2.9×10^4 particles per cubic metre at a particle size of 5.0 microns or greater. These target levels are consistent with Class 8 conditions as determined by ISO14644, and we believe they should be achievable in an environment which is mechanically ventilated by a properly designed, maintained and operated system.

The airborne particulate measurements carried out using the laser particle counter showed results for both the larger and smaller particle size below the target limits described above. Whilst this may be considered very satisfactory, it should be noted there was no activity in the Locker Corridor at the time of the test, but the tests taken in the General Purpose Room were taken immediately after a fairly full class had completed. These results may therefore be considered satisfactory.

OCCUPIED SPACE CONDITIONS

TEST: Contaminant Gases

OBJECTIVES: To confirm that normal air conditions and gas levels are present in the occupied area

METHOD: GASTEC Gas Analysis Tubes and Testo CO₂ detector for measurement of the gases specified below

RESULTS:

<u>Location No.</u>	<u>Occupancy</u>	<u>Location</u>	Concentration of gas (ppm)			
			<u>Carbon Dioxide</u>	<u>Ozone</u>	<u>Formal-dehyde</u>	<u>Carbon Monoxide</u>
1	0%	Locker Corridor	636	<0.025	<0.01	<0.1
2	Just after full class	GP Room	649	<0.025	<0.01	<0.1
		Recommended Upper Limit	800	0.025	0.1	3.0
		<i>External</i>	492	-	-	0.0

Results above the recommended limit are shown in bold

OCCUPIED SPACE CONDITIONS

Contaminant Gases

Carbon dioxide is a by-product of combustion and respiration, and is present to some extent in all atmospheres. As the concentration of carbon dioxide increases, occupants can begin to feel that the atmosphere stuffy and unpleasant, with higher levels inducing drowsiness and lethargy, along with perceived higher temperatures. The first effects can be felt by the most sensitive subjects at about 1,000 parts per million (ppm) if other environmental parameters are also unfavourable. Westfield Caledonian recommend that in an office environment the carbon dioxide concentration be maintained below 800 ppm. This is consistent with recommendations outlined in Building Services Research and Information Association (BSRIA) Technical Note 4/88 and information provided by Chartered Institution of Building Services Engineers (CIBSE).

Carbon monoxide is a by-product of incomplete combustion and is harmful to health. The current UK limit on exposure for this substance is that set under the Control of Substances Hazardous to Health (COSHH) Regulations 2002 and published within the Health & Safety Executive document Environmental Hygiene (EH) 40/2003 "Workplace Exposure Limits 2003". This sets a limit of 30 ppm for occupant exposure over a time weighted period of eight hours. Westfield Caledonian recommend that as a general rule, office and light manual staff be subject to no more than 10% of the COSHH Workplace Exposure Limit. Therefore, the recommended maximum level for carbon monoxide is 3 ppm.

Ozone is a by-product of high temperatures processes and can be produced by badly maintained photocopiers, fax machines and laser printers. It is a strong oxidising agent and produces a variety of adverse effects in the most sensitive of people at very low levels. These are symptoms can include general irritation of the tracheal bronchial and respiratory tract. For this reason, the recommended maximum level is 0.01 ppm, which is the threshold of smell.

Formaldehyde is the solvent base for a large range of materials used in buildings. It is harmful to health, causing inflammation of the mucous membranes and allergic contact dermatitis although has been implicated in causing occupational asthma.

OCCUPIED SPACE CONDITIONS

The tests confirmed the absence of the gaseous contaminants formaldehyde, ozone and carbon monoxide, and not only were the carbon dioxide concentrations well below the target upper limit of 800ppm, but was largely consistent with the external carbon dioxide concentrations. It may be considered therefore that these results are very satisfactory, particularly for the General Purpose Room, where a well-attended class had just completed. It may be considered therefore, that appropriate volumes of fresh air are being supplied to these areas.

OCCUPIED SPACE CONDITIONS

TEST: Microbiological testing of air within the occupied areas

OBJECTIVES: To assess the degree of airborne bacteria contamination present

METHOD: Sampling with Surface Air Sampler onto nutrient agar plates, followed by subsequent incubation and examination

RESULTS:

Sample No.	Occupancy	Location	Total no. of colony forming units (CFUs) per m ³	Bacteria species present
1	0%	Locker Corridor	30	Staphylococcus
2	Just after full class	GP Room	440	Mixed Staphylococcus
		Recommended Upper Limit:	<1000	

Results above the recommended limit are shown in bold

OCCUPIED SPACE CONDITIONS

TEST: Microbiological testing of air within the occupied areas

OBJECTIVES: To assess the degree of airborne fungal contamination present

METHOD: Sampling with Surface Air Sampler onto Sabouraud agar plates, followed by subsequent incubation and examination

RESULTS:

Sample No.	Occupancy	Location	Total no. of colony forming units (CFUs) per m ³	Fungal species present
1	0%	Locker Corridor	50	Aspergillus Mucor
2	Just after full class	GP Room	60	Mixed Aspergillus
		Recommended Upper Limit:	<1000	

OCCUPIED SPACE CONDITIONS

Airborne Micro-organisms

Micro-organisms are present in every environment and occur naturally in the external environment. The parameter being measured within the survey is the total microbiological contamination which is an indication of the infection risk and species are given primarily for completeness of information.

With respect to what are acceptable limits, the Chartered Institute of Building Services Engineers (CIBSE) has produced a guidance document (TM26) which gives the following microbial limits when air sampling.

Category	CFUs per metre³
Low	<100
Medium	>100 and <1000
High	>1000

These results confirm the airborne microbiological activity to be in the Low range for three of the tests, with the fungal test in the GP Room in the Medium category. Given this latter test was carried out immediately after a high activity class, where a high level of this type of contaminant might be expected to be produced, it may be considered the results are satisfactory, and that sufficient volumes of fresh air are being introduced to the served areas to adequately dilute internally generated contaminants.

OCCUPIED SPACE CONDITIONS

TEST: Environmental comfort conditions

OBJECTIVES: To measure the parameters which dictate the degree of comfort discerned by occupants

METHOD: Vaisala temperature and humidity probe

<u>Location No.</u>	<u>Occupancy</u>	<u>Locations</u>	<u>Dry Bulb Temp °C</u>	<u>Dry Resultant Temp °C</u>	<u>Relative Humidity (%)</u>
1	0%	Locker Corridor	19.3	19.4	52.3
2	Just after full class	GP Room	19.6	19.5	54.8
		Recommended Range:	20°C -25°C		40-70
		<i>External</i>			

OCCUPIED SPACE CONDITIONS

Environmental Comfort Conditions

The measured and derived parameters are assessed by comparison with the recommended conditions for thermal comfort given by the Chartered Institution of Buildings Services Engineers (CIBSE). CIBSE recommends that dry resultant temperatures (a combination of air temperature and mean radiant temperature) lying between 19°C and 23°C should provide comfort conditions for the majority of people in sedentary or light activities. In summer, conditions the comfort range can be taken as 20°C to 25°C as generally people are acclimatised to the higher temperatures and tend to wear lighter clothing.

The comfort range for relative humidity is given as 40% to 70% by CIBSE. Within this band, the majority of occupants should feel no discomfort or static electricity build up.

The recorded Relative Humidities of 52.3% and 54.8% were ideally in the middle of the CIBSE recommended range. It should be noted however that humidity levels are dependant on the prevalent external ambient conditions at the time of the survey, as the ventilation system serving this area has no humidity control capability. The Dry Resultant Temperatures and Dry Bulb temperatures were slightly below the CIBSE range, but given the nature of activities, cooler temperatures may be preferred in this environment than would be expected where more sedentary activities are involved. No recommendations are made however in respect of these environmental comfort measurements.

RECOMMENDATIONS SUMMARY

ITEM

RECOMMENDATIONS

AHU No. 3

Fresh Air Intake

- Install access to this duct section to facilitate inspection, and hygienic and mechanical maintenance activities.

Filter Section

- Ensure appropriate sealing strips are applied to the mating faces of connected filter cartridges, to eliminate filter bypass.
- Where possible, ensure bag filters are installed with the pockets in the vertical plane to ensure full inflation of the pockets.

Conditioning Components

- Carryout vacuum combing of battery fins to both improve mechanical condition and maintain good hygienic condition.

All Sections

- Introduce inspection and cleaning of AHU components, ensuring removal of all deposited particulate and debris. Areas of oxidation should be treated and coated.