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Evaluation of ID-500 Units Installed in Air Conditioning at Star City Casino, VIP Lounge.

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Summary

Ionisation of the air in the VIP Room at Star City Casino, resulted in

i. a reduction of bacteria levels in the air by 52%
ii. a reduction in dust particles by 45%
iii. no change in human, food or smoke odours
iv. no detectable levels of ozone (<0.003 ppm) in both the ducts and VIP Room.

The tests were performed when the usage of the room was low, if tests had been done when the usage of the room was high, the differences in air quality due to ionization would have been expected to be much larger.

Background

The effect of ionisation on air quality by two ID-500 ionisation units installed in the air conditioning ducting was examined at Star City Casino, VIP Lounge. The air to this area is not recirculated, but instead supplied at a rate of about 24,000 litres/min into a room of approximately 1,100 m^3 volume, this means that the air in the VIP lounge is fully replaced about every 40 minutes. There had been problems with odours and air quality in this room and the ionization technology was installed to attempt to improve the air quality.

A variety of tests were performed to determine the air quality in the room by sampling from numerous locations throughout the room. Tests were done with the ionization machines turned off and then with the ionization turned on. These tests included

- Air-borne microorganisms, both mould (using MEA agar) and bacteria (using NA agar)
- Air particles (dust and fibres etc) – particles >10µm per m^3
- Odours – the sampling and analysis methods used (gas chromatography and SPME sampling) can monitor a range of human, food and smoke odours in the air.
- Ozone production using two technologies
  - i a portable meter based on gas sensitive semiconductors and
  - ii chemical reactive tubes using Draeger gas sampling and analysis technology.

The tests were performed in the VIP room and the two air conditioning ducts supplying these rooms between 6.30 and 8.30 am on the mornings of Wednesday the 5th and Thursday the 6th of July, and with follow up ozone tests on Tuesday the 18th July. At this time of the day, the number of patrons in the room was very low, with a maximum of fifteen patrons and a maximum of five staff in the room during this time. The ionisation units were turned off one hour prior to the no ionization tests (which may result in some carryover benefit from

ionization effects), while for the ionization tests the units had been running for over 18 hours.

Results

1. Air-borne microorganisms

Petri dishes containing different media to promote bacterial and mould growth (Nutrient Agar and Malt Extract Agar, respectively) were exposed to the air for various times with and without ionisation in the VIP lounge, Star City Casino.

When all times were averaged, the bacterial levels in the air were reduced on average by more than 50% when the ionization unit was running (Table 1), while the reduction in mould levels was lower at only 9% on average. For more definitive results, further collection of air-borne microorganisms is recommended at longer exposure times, particularly when there is a high load of persons in the area.

Table 1. Reduction in mould and bacteria in the air in the VIP room, Star City Casino.

Time the test plate was exposed (minutes)	**No ionization (per plate)**	**With ionization (per plate)**	**% reduction due to ionization**
Mould			
0.03	0.25	0.25	0%
1:00	0.5	0	100%
3:00	0	0	0%
10:00	0.75	1	-33%
30:00	1.25	1.5	-20%
Average effect on mould			***9% reduction***
Bacteria			
0:03	0.5	0	100%
1:00	1.25	0.25	80%
3:00	0.5	0.5	0%
10:00	1	0.5	50%
30:00	3.25	2.25	31%
Average effect on bacteria			***52% reduction***

2. Air particles

Air was passed through a Millipore 37mm Aerosol Analysis Monitor with 0.8 µm (MAWP037A0) at 4.5 L/min for 30 minutes using a vacuum pump in order to capture particles in the air. Particles embedded on the filters greater than 10µm were counted using a binocular microscope with 80x magnification.

iii. Average particle count for no ionisation present was 533 / m^3,
iv. Average particle count for ionisation units turned on was 295/m^3.

This is a reduction in particles in the air down to almost a half (45%) of the previous levels due to the ionisation of the air.

However, both these air samples are relatively clean and fit within the outer limits of clean rooms as defined in British Standards BS 5295 for Class of Environmental Cleanliness Levels J (0 – 450 particles/m^3) and K (451 – 4500 particles/m^3). A larger difference due to ionization with more definite results, would be expected to occur with a higher particle load in the air.

3. Odours

Air at the casino was sampled in 45ml vials, which were exposed to the air for 60 minutes before being sealed. Prior to analysis for odours, the vials were heated to 50C for 15 minutes to ensure that no odours were attached to the sides of the vials. Odours were then concentrated by being absorbed for 30 minutes onto SPME fibres. Samples were then analysed by gas chromatography using a temperature gradient from 40 to 220C and a FID detector.

Average total peak area counts of aromas in the air for eight samples

i. Without ionisation aroma total peak areas = 6220
ii. With ionisation aroma total peak areas = 6555

There is no significant difference in aromas in the air with or without air ionisation. The levels of human, food and smoke odours or aromas in the air were very low and hence do not allow significant differences to be fully tested determined. More definite results would be expected if air samples were taken when the air was recognizably tainted (*eg*. during garbage collection times near air intakes ducts) or when a large number of people were present in the room.

4. Ozone

Two types of ozone detecting equipment were used namely the Draeger Multi Gas Detector Draeger ozone gas tubes (Part No. 6733181) based on sampling a precise volume of air and a specific reaction with chemical agents and the Aeroqual Ozone Series 500 Ozone Monitor based on gas sensitive semiconductor technology.

Since slightly different results were obtained by each technology at very low ozone levels, they were tested under a range of ozone levels (Table 2). It seems that for moderate to low ozone levels ($\geq$ 0.1 ppm) electronic based ozone meters based on gas sensitive semiconductors are adequate and very similar to Draeger Tube values. However, for low to very low ozone levels of $\leq$ 0.05 ppm and especially for ozone free air Draeger gas tubes are much more accurate.

Table 2 Comparison of Two Ozone Measurement Technologies for Accuracy at Different Ozone Levels

Ozone Level ppm	Aeroqual Series 500 Ozone Monitor			Draeger Ozone Tubes	
	Average ppm (over 10 min)	Minimum	Maximum	Sample Size ml	Value ppm
0.000 (ozone free)	0.025	0.000	0.046	1,000	< 0.001
~ 0.1 ppm	0.118	0.081	0.126	100, 200	0.125
~ 0.5 ppm	0.526	0.489	0.566	100	0.55

Ozone measurements were made in the two ducts through access ports and in the centre of the ducts. In the VIP Room ozone measurements were made at chest level under the air delivery vents and in the centre of the room half way between the delivery and air return vents. The results are described in Table 3. The most accurate measurements based on the tests performed at standard ozone levels are with the Draeger tubes, these show that ozone is below measurable levels of 0.003 ppm in both the ducts and the VIP room.

Table 3 Ozone Levels detected in Air Conditioning Ducts and VIP Room at Star City Casino by Two Ozone Measurement Technologies

Location	Aeroqual Series 500 Ozone Monitor			Draeger Ozone Tubes	
	Average ppm (over 5 min)	Minimum	Maximum	Sample Size ml	Value ppm
Duct 1	0.005	0.000	0.009	300	< 0.003
Duct 2	0.004	0.000	0.011	300	< 0.003
VIP Room, air delivery	0.021	0.000	0.043	300	< 0.003
VIP Room, centre of room				300	<0.003

The Aeroqual Ozone Monitor indicated that in the ducts ozone levels were very low and that they were no different from a zero ozone level, within the limit of accuracy for the meter of ±0.010 ppm. In the VIP Room, the Aeroqual Ozone Monitor gave one of the eight ozone readings as 0.043 ppm, which resulted in an average ozone of 0.021 ppm. This value is incorrect for two reasons, firstly the Draeger Ozone tubes are more accurate at these low levels and secondly the highest ozone levels if generated by the air ionizer must be in the air ducts, which are diluted down in the room as the air is replaced every approximately 40 minutes. Therefore, room ozone levels in the room must be lower than the ozone levels in the air duct.

In summary, ozone levels in both the ducts and the VIP Room are below the lower detection limits of the Draeger Ozone Tubes of 0.003 ppm ozone. Ozone levels in the room are therefore well below the maximum eight hour limit of 0.1 ppm ozone, as they are below the most accurate limit of detection, which is less than 3% of the current Australian standard limit for ozone.

Signed

Dr Stephen Morris