SECTION VI

SUMMARY

6. SUMMARY

The results from the cases studied show:

- The number of particles vented out of the room increases with ACH. The variation with ACH is more pronounced for winter cases with no baseboard heating than for summer cases.

The reason for this, as demonstrated in Memarzadeh and Manning (2000), is that the flow fields for cases which have the same ACH, but different weather conditions, show dramatically different flow patterns in the room. In particular, ventilation effectiveness is much better in the summer cases.

- Cases with high exhausts grilles vent out more particles than low exhaust grilles systems for the particle release points considered in this study for the low to medium ACH values considered. This trend is not present at the higher values of ACH considered. The likely reason for this is that greater turbulence is present at high level on increasing ACH which prevent the particles from venting.

- In terms of the effectiveness of the UVGI, there is little advantage in increasing the ventilation rate in the room beyond 6 ACH for summer cases, or for winter cases with baseboard heating. In particular, beyond this point, the number of particles killed by the UVGI generally decreases.

The value of 6 ACH is consistent with the results of a concurrent study examining thermal comfort and uniformity in patient rooms, as documented in the study conducted by Memarzadeh and Manning (2000). In particular, this study suggests that the optimum ventilation rate for similar winter conditions as considered here is 6 ACH to provide good levels of thermal comfort and uniformity. This value is also suitable for summer condition cases.

- The number of viable particles is generally lower for high exhaust systems than low exhaust systems for the particle release points considered for the low to medium ACH values considered. This trend is not present at the higher values of ACH considered. However, when baseboard heating is used, the low exhausts perform better than the high level exhausts for the two higher UV power levels considered. There is no obvious reason for this contradiction

- For the effectiveness of UVGI, the best ventilation rates seem to fall in the range of 10-12 ACH for winter without baseboard heating and 6ACH for summer and winter cases with baseboard heating with the UVGI location being studied.

- UVGI kills a significant percentage of the viable particles in the room. In particular, as seen in the Table 6.1 example, UVGI kills more than 50% of the particles in the room after 5 minutes, even for the lowest UVGI levels tested.

- The addition of baseboard heating results in better UVGI killing rates irrespective of ACH. Baseboard heating should therefore be used in winter cases, especially at low ACH.

- No obvious tendency is observed from the increased pressurization of the room.

- For a direct comparison between the different UV levels, the percentage of killed particles with a 10 ACH ventilation flow rate and the UVGI located on the wall near the bed, are listed in Table 6.1. It indicates that for winter condition, increase of UV output from 10W to 20W enhances UV killing by 20%. Further increase of the output results in no significant improvement of UVGI performance. For summer condition, the UVGI is generally not as effective as in winter condition. This may be due the higher mixing in the summer condition that prevents the particles from spending longer time in the upper room where the UV intensity is higher.

Table 6.1 Percentage of killed particles after 300 seconds at 10 ACH

	10W	**20W**	**40W**
Winter	65%	90%	94%
Summer Peak T	46%	60%	75%

- The addition of UVGI offers a clear advantage over increasing the ACH in the ventilation system. For example, for the UV1 case, an increase from 6 to 16 ACH results in a drop of 30% in the viable particle total if UVGI was not present for summer cases. However, the introduction of UVGI results in a reduction of 68% in the number of viable particles at 6 ACH. At current costs, the inclusion of UVGI is also considerably cheaper ($1742 compared with $9000 over a ten year period for a 200 ft^2 room).

- The reduction in the number of viable particles on doubling the UV intensity for summer cases and winter cases with baseboard heating at 6 ACH is around 20%. This indicates that increasing the UV intensity is not necessarily cost effective. At current costs, this would mean an increase of $1615 ($4844 for the UV3 system compared with $3229 for

the UV2 system over a ten year period for a 200 ft^2 room), the majority of which is associated with installation, not running costs.

Based on the above, the following design recommendations are made:

1/ Baseboard heating is included in winter scenarios. The addition of baseboard heating is roughly equivalent to an increase of 6 ACH.

2/ UVGI offers significant advantages in terms of reducing the number of viable particles, and should be included.

3/ It is recommended that a value of 6 ACH be utilized as a ventilation rate for extreme summer conditions, and winter conditions with baseboard heating. There are three reasons for this recommendation:

i/ Above 6 ACH, the number of particles killed by UVGI is not increased significantly except for very high values of ACH.
ii/ The cost of each additional ACH is very expensive at current costs, in particular, around $90 per year per ACH for a single 1800ft^3 room. For the same figure of $90 per year, an extremely efficient UVGI lamp can be located in the room.
iii/ The value of 6 ACH is also sufficient to provide good thermal comfort and uniformity in the room.

4/ Doubling the UV intensity only results in a further 20% reduction in the number of viable particles, and is expensive in terms of the initial outlay of equipment. From this viewpoint, expensive UV systems are not that cost effective, and the current recommendation of 30W per 200 ft^2 (First et. al Part II (1999)), which represents the UV1 location scenario in this study, is adequate.

5/ The UV lamp should be located 7.5’ above floor level. No clear conclusion can be drawn as to its location in the room because of the cases considered. However, the placement of the UV lamp immediately above the bed is reasonable so that it is directly out of eye contact with the patient.