# Performance evaluation of IVC systems

## Summary Report of the Working Group on Evaluation of IVC Systems of the Animal Welfare Information Center for Biomedical Research of the Faculty of Medicine (TierschutzInformationsZentrum für die Biomedizinische Forschung (TIZ-BIFO), Klinikum Innenstadt, Ludwig-Maximilians-Universität (LMU) München), Munich, Germany

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## Summary

An expert Working Group was set up in December 2000 to develop recommendations for users and industry on the evaluation of proper function and operation of individually ventilated cage (IVC) systems. The full report of their recommendations is in two parts—'Part 1: Test Instructions' and 'Part 2: Evaluation Criteria'—both of which have been published in full on the Laboratory Animals Ltd website. They can be found at http://www.lal.org.uk/IVC/index.html. Evaluation of and feedback on the recommendations to further refine their use and scientific basis is encouraged. This Summary Report provides a brief overview of the background to the development of the full report and the issues it addresses.

**Keywords** Individually ventilated cage (IVC) systems; ventilated cage systems; relevant parameters for housing of animals; animal welfare; IVC systems; standardization of housing conditions for laboratory animals; animal husbandry; rodents; housing; cage microenvironment; carbon dioxide; ammonia; differential pressure; allergens; ergonomics

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Over the last 20 years new cage systems for housing rodents (especially transgenic mice) have been developed and extensively introduced into the market. One of the principal ideas has been the development of housing systems offering a level of containment in between the closed (barrier) system as described by GV–SOLAS (1989) and an isolator system. These have become known as individually ventilated cage (IVC) systems. With proper handling the IVC system can provide a barrier at the cage level.

There are several advantages with this type of caging. Important potential benefits include: small groups of animals are protected against each other and from the environment; the environment is protected from the animals (such as in infection studies, reduction of allergen exposure); and there can be compensation for poor air change rates in an existing room.

There are also potential problems: higher investment cost; an increase in the time spent per animal during cage-changing; the necessity to ensure the proper function of IVCs; and handling and maintenance of a much more complex technical system relative to those currently used in animal laboratories. In comparison with open caging, it is much more difficult for users to check effective operation as airflow is invisible and designed to be non-turbulent to avoid stress to the animals.

Also in contrast to open cage systems, where much work was done in the 1960s and early 1970s to standardize housing conditions, IVC systems have been introduced rapidly into animal facilities, and without full definition of relevant animal housing parameters.

## Background to the recommendations

In December 2000, the Animal Welfare Information Centre for Biomedical Research of the Faculty of Medicine (TierschutzInformationsZentrum für die Biomedizinische Forschung (TIZ-BIFO), Klinikum der LMU), Munich, established an initiative to address the definition of relevant animal housing parameters. A key target was to develop ventilation standards of IVC systems relevant to good housing of animals, in particular mice and rats.

In addition, commercial producers of IVC systems all have an interest in harmonization towards good standards, and measurement systems for such standards, such that all users can objectively compare products.

There is a wide range of parties interested in IVCs and it was felt important to ensure wide participation. An inaugural meeting on 20 February 2001 included 50 experts—users, independent bodies, producers, members of different GV–SOLAS working groups

**Box 1 Performance Evaluation of IVC systems—Part 1: Test Instructions**
(http://www.lal.org.uk/IVC/index.html)

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**Box 2 Performance Evaluation of IVC systems—Part 2: Evaluation Criteria**
(http://www.lal.org.uk/IVC/index.html)

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and of the expert groups advising the Council of Europe on revision of ETS123, and many others. Two internal Working Groups were established: one of industry/engineers (*see* Box 1) and the other of users/veterinary surgeons (*see* Box 2). At a second plenary conference on 29 May 2001 in Munich, the main ventilation-related parameters were agreed and there was also agreement on the more complex task of methods to measure those parameters. The results of further discussions were reviewed and presented at the third plenary conference in association with the GV–SOLAS meeting on 13 September 2001 in Ulm. This process is outlined in Fig 1.

The discussions defined the relevant ventilation-related parameters as:

- the air velocity in the cages at two/three levels;
- the air-change rates in the cages (in total, and at different places in the cage);
- the differential pressure between the inside of the cage and the room;
- the rate of leakage (volume of unfiltered air out of/into the cage);
- the possibility of (cross-) contamination by incorrect air movement.

Standards for noise level and vibrations and for filter materials were also agreed.

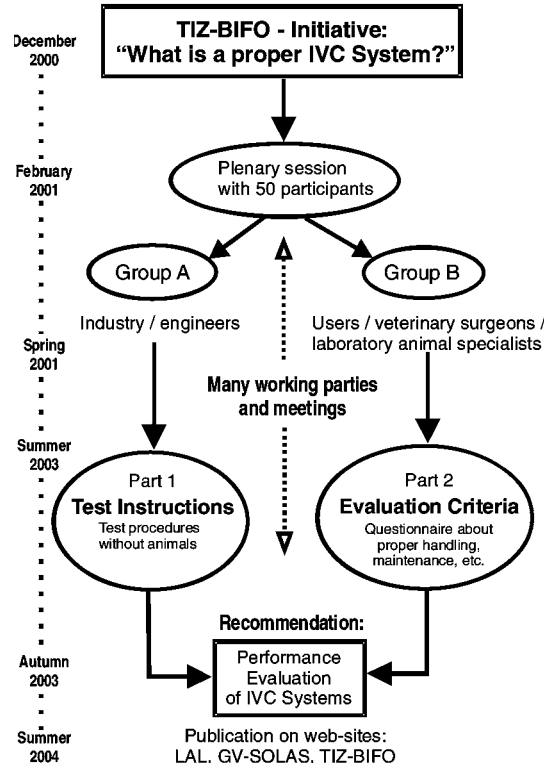


**Fig 1 Overview of the development of the TIZ-BIFO initiative from the inaugural meeting to the new recommendations: 'Performance Evaluation of IVC Systems'**. Parts 1 and 2 of the recommendations can be found at http://www.lal.org.uk/IVC/index.html

Apart from the parameters of the above test procedures, it also became evident that the practical aspects of working with the equipment should be integrated into standards in order to assist users in the evaluation of IVC systems for their specific applications. These practical aspects include:

- matching cage—wire lid—cage lid—bottle;
- matching of cage and rack;
- changing the different filters;
- hygienic aspects;
- operating instructions;
- service—maintenance;
- inspection and safety functions.

Those involved concluded with the following structure for presenting the group's current conclusions:

- Part 1: Test Instructions.
- Part 2: Evaluation Criteria.

In Part 1 all the tests that are required to check the necessary parameters for the proper distribution of air, climatic and acoustic parameters, filter specifications and error messages (alarms) are described. Part 2 operates as a questionnaire.

The Working Group started with the view that an ideal position would be that all tests be performed in the presence of animals, bedding and other material. However, it was recognized that this can present practical, logistical and especially financial problems, and therefore it was agreed that all the tests in general would be performed in the absence of animals and other materials. However, some manufacturers may choose to perform some tests with animals (or heat sources which simulate animals) and other materials present. In this case if a producer varies the parameters in the testing schedule, for example adding animals, then this modification must be clearly stated.

Two other issues arose during discussions. First, there was consideration of the approach of certification (defined as testing against an agreed public specification by an independent body) as compared to qualification (testing normally done by the producers themselves). At this stage of the evolution of standards for IVC systems, the resolution of these discussions was that performance evaluation by each producer was currently the most acceptable approach. Second, air blowers were excluded from the discussions. Although most IVC systems have air blowers shipped by the producers of the racks, and installed together with the racks as an independent system, there are some products where the ventilation is via a central air supply unit located elsewhere in the building. On performance criteria at cage level, it is irrelevant how the air is supplied and tests on all possible combinations of blowers and racks would add too much complexity.

## Conclusion

The original task was to create reliable recommendations, for users and industry, on the evaluation of proper function and operation of IVC systems. The two parts of the Working Group's full report—'Test Instructions' and 'Evaluation Criteria'—are important first steps towards this objective. Additional experience in laboratories while working with the animals will show if other animal-related or operator-related aspects should be integrated. We invite all those interested in IVCs, whether they be scientists using animals, those involved in animal husbandry and veterinary care of the animals, those managing staff, health and safety professionals, producers of IVCs, engineers, those focused on animal welfare and others, to all provide comments towards refining these recommendations, their applicability, suitability, relevance and cost-effectiveness and to provide critical review to enhance their scientific basis.

The 'Test Instructions' and the 'Evaluation Criteria' are published on the Laboratory Animals Ltd website at http://www.lal.org.uk/IVC/index.html, thus allowing their download, use, evaluation and feedback. Versions in German are available at http://www.gv-solas.de/publ/ ivc.pdf and http://www.tiz-bifo.med.uni-muenchen.de/ #Publikationen.

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