BIOSAFETY-EUROPE

Report on the cost effectiveness of current Biosafety/Biosecurity measures and methods in high containment laboratories

SIXTH FRAMEWORK
PROGRAMME

1. Introduction

The process of cost effectiveness analyses involves weighing the total expected costs against the total expected benefits of one or more actions in order to choose the best or most safe option. In order to take any decision to choose the appropriate measures to guarantee a safe handling of biological agents, information about the impact of such measures, their costs and the consequences (advantages and disadvantages) of choosing one option over another should be known. Cost-effectiveness analysis is an analytical tool whose purpose is to provide information about the relative value of different approaches.

The results of the two questionnaires sent out to over 300 laboratories did not allow any conclusions with regard to cost-effectiveness of biosafety and biosecurity measures and show that cost-effectiveness analysis are not performed routinely in biosafety and biosecurity. Furthermore, societal consensus in defining the acceptable risk which could serve as a rule for cost-effectiveness analyses is missing.

The following findings are based on the information gained in the workshops of the project, an expert hearing in Germany (June 2008) and the consortium **member's** knowledge and experience. Based on the results of all this we can conclude that it is impossible to compare real costs of high containment facilities among each other and among different European countries. Furthermore comparison of containment level 4 laboratories among each other is not possible since every containment level 4 is an individual solution whereas containment level 3 laboratories can be better compared.

These findings will be worked out in the following report.

2. Partition of costs:

When assessing the partition of costs, the following stages of the design and construction process of containment level 3 and 4 facilities have to be envisaged:

- ⇨ Planning phase: programme requirement, concept development, conceptual design, risk assessment, final design, permits, awarding the contractor
- ⇨ Construction including commissioning /validation
- ⇨ Putting into service (biological validation, develop biosafety and biosecurity management system including manuals and procedures)

Once construction is competed the following long-term costs have to be taken into consideration:

- ⇨ Running costs including preventive and routine maintenance costs
- ⇨ Programme costs (scientific): out of the scope of this document

2.1 Planning phase:

The planning of containment level 4 laboratories is time consuming because the analysis and establishment of requirements constitute a continuous development process. Only after finishing the detailed user requirements, the development of the design and the risk assessment the realistic costs can be established and budgeting can be carried out. That is why the usual planning procedures for standard construction projects cannot be carried out for a containment level 4 facility.
All considerable delays occurring in the planning phase are very cost-intensive. Because of the complexity of high containment laboratories involvement of biosafety and biosecurity experts is needed from the start. A proper description of responsibilities and competences is a prerequisite for a successful project.

Cost reduction through optimization of the planning phase requires:

- Continuous participation of all persons and institutions involved, especially of BSO, researchers, competent authorities, architects and engineers.
- Continuous monitoring and controlling of the budget
- Selection of planners and constructors under the aspect of verifiable specific qualification; criteria shall be established in the project tenders.
- Risk assessment to assess necessary containment elements prior to finish the final design
- Design review by competent authorities and containment experts to avoid major failures
- Flexible, modular construction method to avoid later reengineering: that is more cost-effective and allows better capacity use

Early development of a management concept parallel to planning and involvement of all stakeholders reduces the running costs. In any case cost savings on biosafety and biosecurity elements should be considered carefully since safety elements should always be more important than architectural aspects.

Annex I: Some examples of partition of costs

2.2 Construction including commissioning and validation

Continuous, qualified and independent monitoring of construction is indispensable to ensure that later no safety problems will occur due to construction errors. This includes the requirement on the quality of physical construction and relevant technical components as well as on redundancies. This process is designed to ensure that the completed facility, equipment and systems will operate in accordance with the program requirements and the design documents. The costs of this continuous monitoring have to be taken into account from the start. In addition a validation master plan should be developed which describes the items of the design related to containment that should be part of the validation. This validation process is meant to proof biosafety and biosecurity of the design. The validation process has to start together with the construction phase.
Annex II: Construction costs breakdown of a large animal facility in North America (containment level 3Ag)
Annex III: Elements to be considered in commissioning and validation

2.3 Putting into service

After handing-over of the facility by the contractor biological validation and the establishment of a biosafety and biosecurity management programme should be performed by the user prior to the start of the scientific programme. This does not offer any cost-saving possibility. The costs should be included in the budget calculation.

2.4 Running costs including maintenance

Running and maintaining high containment facilities are expensive since eg. energy consumption or waste treatment do not allow any economies. (Remark: Even more expensive are facilities for large animals) The running costs will rapidly go beyond the investment costs. Experience has shown that running (operating) costs reach the level of investment costs after approximately 5 to 10 years.[1]
Running and preventive and routine maintenance costs have to be calculated in advance and long term funding should be guaranteed. Cut downs in funding should never lead to decrease the safety level.
Modifications in the scientific programme leads to re-evaluation of the risk assessment, the biosafety and biosecurity measures, and may lead to increased biosafety/biosecurity programme costs.
In high containment facilities additional costs for security measures will arise dependant on national legislation and localisation of the facility.
Attention should be paid to the circumstance that the national economic situation may also influence the level of biosafety and biosecurity measures to save costs.

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[1] German Expert Hearing, June 2008

a) Maintenance

Dedicated maintenance personnel with overall knowledge of the technical installations have to be appointed and enough financial resources have to be foreseen. Additionally, agreements with contractors defining availability on short notice and availability of critical component of technical equipment are necessary to guarantee uninterrupted safety and will raise costs. Outsourcing of technical maintenance or employment of insufficiently qualified personnel increases the safety risk.

The following items should be considered when setting up the building maintenance and management plan:

- Salaries
- Utilities (water, hydro, sewers, telephone, data etc.)
- Utility consumption trends and analysis
- Energy management control and conversion programs
- Service and maintenance contracts
- Supplies and materials
- Administration
- Ground / landscaping and parking lot maintenance
- Contingency for unforeseen occurrences
- Spare parts and materials
- Minor repair projects (eg. paintings, pumps, valves etc.)
- Major repair projects (eg. new autoclaves, new HVAC etc.)

b) Biosafety/biosecurity programme costs

Biosafety and biosecurity are a continuous task of dedicated personnel. There must be a sufficient number of specifically trained staff members for biosafety and biosecurity to ensure safe and continuous operation and the controlling of emergency (cases) Continuous training of all personnel working in high containment facilities affects the budget of the running costs.

3. Outcome

3.1 Deficits

Existing legislations (biological agents and GMO legislation) have to be updated and harmonised. Technical measures are unspecific, not state of the art and not evidence based, so that time-consuming and cost-intensive individual solutions have to be worked out. In particular, this applies measures in terms of fire protection, negative pressure cascades, leak-tightness, choice of suitable filter- and waste treatment systems. This includes also the standard and quality of technical and constructional components.

There may be considerable cost differences between comparable establishments. In this regard, significantly higher costs arise from BSL 4 – animal rooms.

One reason for these differences is the fact that because of existing uncertainties concerning applicable safety requirements, maximum safety requirements are imposed without proof that they are actually necessary.

Technical equipment is very expensive and technical solutions are competing each other due to scarce resources. Safety and security are essential but should dictate optimal and not maximal solutions. In contrast to this – today's policy - especially concerning biosecurity - prefers maximal solutions. It needs an international risk-discussion as basis for the decision which solutions really are optimal. The optimal solution should be risk/evidence based and the result of a cost-effectiveness analysis.

Since the information on laboratory acquired infections collected throughout the project was not standardised or was missing we could not take any conclusion on how effective certain safety measures are or which safety measures would be most cost efficient.

By defining uniform European optimum requirements, these costs could be minimized. In many cases, the definition of the technical state of the art requires prior research and exchange of experience with existing high containment facilities.

By optimizing the planning phase and establishing risk/evidence-based safety requirements, harmonised in member states of the EU, the costs can be cut down without reducing the safety level.

However, personnel, maintenance and repair costs do not offer any cost-saving possibilities.

During the term of the project and the discussion in the work shops the following open questions occur and should also be integrated in an international risk-discussion:

- How is the actual risk by risk group 4 micro organisms to be assessed?
- Will the current cost development influence research activities with risk group 4 micro organisms?
- Are laboratory accidents rather due to human error or technical failure?
- How is the risk of complex technical systems to be assessed with regard to the human-technology interaction?
- How will new technologies influence the risk discussions in biosafety and biosecurity?

ANNEX I:

The following partition of the costs is a result from the German Expert Meeting on 3rd of June 2008, Hannover, Germany.

Example of the partition of the costs in Germany of a containment level 4

Planning costs (e.g. studies, concepts, research and development as well as planning of design and authorisation)	up to 20 % of overall costs
Construction	up to 80 % of overall costs
Putting into service (biological validation)	up to 2 %

Technical costs amount to ~ 50 to 70 % of overall costs which were split up into

HVAC system	~ 25 to 35 %
Containment 10-20%	~ 10 to 20%
Laboratory equipment	~ 1 to 15%
Heating/cooling	~ 10 to 15 %
Electricity	~ 10 to 18%
Thermal sewage treatment	~ 10 to 18%

In this context, overall costs are composed of costs for construction, operation, disposal and reengineering, where applicable. Building material

Example of the partition of the costs of an other containment level 4 in W-Europe:

Design	8 %
Risk assessments, Validation Master plan	2 %
Permits	1 %
Advisory costs	5 %
Construction costs	46 %
Technical installations + inventory	20 %
Security costs	6 %
Management	12 %
Running costs / pro year including rent excluding scientific program	12 %

ANNEX II:

Example of Construction Costs, Veterinary Containment Facilities, Design & Construction Handbook, P. Mani, P. Langevin, International Veterinary Biosafety Working Group, 2006, **http://www.tecrisk.com/projekte/projekt1/Handbook_070323.pdf**

Construction cost breakdown of a large animal facility in North Amercia (BSL3 Ag). Costs range from 600 to 900USD/m^2. The table represents a summary parametric planning example. Cost ratios would be reduced or enhanced depending on level of containment. The type of fumigation (formaldehyde vs. hydrogen peroxide) may influence the total costs as well.

ANNEX III

References

Report: German Expert Meeting, 3rd June 2008, Hannover, Germany: Kosten-Effektivitäts-Analyse von Biosafety/ Biosecurity-Maßnahmen in BSL 3 und 4 Laboratorien

Feasibility of a Cost-Effectiveness Study for different HEPA filtering arrangement and tight door options, P. Mani and M. Heuer, 2008

Veterinary Containment Facilities, Design & Construction Handbook, P. Mani, P. Langevin, International Veterinary Biosafety Workding Group, 2006, http://www.tecrisk.com/projekte/projekt1/Handbook_070323.pdf

Evidence-Based Biosafety: a Review of the Principles and Effectiveness of Microbiological Containment Measures, T.G. Kimman, E. Smit and M.R. Klein, Clinical Microbiology Reviews, July 2008, p. 403-425

ANNEX IV:

Commissioning/Validation of a laboratory:

- Building automation (eg. integrated control systems, alarming / response etc.)
- Data telecommunications (eg. telephone, data wiring etc.)
- HVAC systems / control (eg. air handling units, dampers, differential pressure control etc.)
- Structural / architectural components (eg. finishes, doors, walls regarding leakproof and resistance to disinfectant)
- Filtration control (eg. HEPA efficiency testing, plumbing vent filters etc.)
- Primary containment systems (eg. Biosafety cabinets, etc.)
- Electrical services (eg. normal power, emergency power, UPS etc.)
- Fire / life safety (eg. system overrides, fire extinguishing systems, breathing air, etc.)
- Decontamination systems (eg. Fumigation systems, decontamination shower, etc.)
- Sterilisation systems (eg. autoclave, killtank, etc.)
- Scientific equipment (eg. imaging systems, robots etc.)
- Animal use systems (eg. penning / caging, carcass treatment etc.)
- Laboratory bench services (eg. CO_2, gas, nitrogen, compressed air, pure water etc.)
- Building / site security (eg. access control devices, CCTV etc.)
- Central services (eg. steam, hot water, chillers, heat exchangers etc.)