Maintainability of High Containment Facilities

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Maintainability

- Definition:
  - The ability to carry out a rapid and reliable system restoration, using ordinary trained people and reasonable support to maintain the equipment at a specified level of performance (INT DEF STAN 00-25)

Maintainability

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Why Maintainability?

- Increase reliability
- Improve task efficiency
- Reduce downtime
- Improve system performance
- Reduce operational errors
- Minimize exposure time
- Minimize incidence

Maintainability Strategies

Organization Policy

Design

Maintenance

Maintainability Strategies

- Organization policy –
  - Budget
  - Risk assessments – level of risk to tolerate
  - Policies on health and safety and security
  - Operation and maintenance activities - in-house, outsource, combination

Maintainability Strategies

- Design stage –
  - Layout of space to facilitate traffic – materials and human
  - Proven technology and mock-ups
  - Comply with legislations, guidelines, standards

Maintainability Strategies

- Maintenance stage –
  - Work closely with other disciplines:
    - Biosafety
    - Environment safety
    - Users
    - Local governments
  - Maintenance schedules
  - Information system – record keeping, asset inventory, maintenance log and records

Design Review

- Participate in design discussion
- Review design drawings and specification
- Participation of commissioning activities

Maintenance Protocols

- Familiar with the Maintenance Protocols:
  - Routine
  - Urgent or emergency
  - Testing
  - Certification
  - Decontamination or fumigation
  - Decommissioning

Envelope

- Envelope construction to facilitate cleaning, decontamination, and integrity - pressure decay

Maintenance Tools

- Knowledgeable of tools used for maintenance

Clearance Spaces

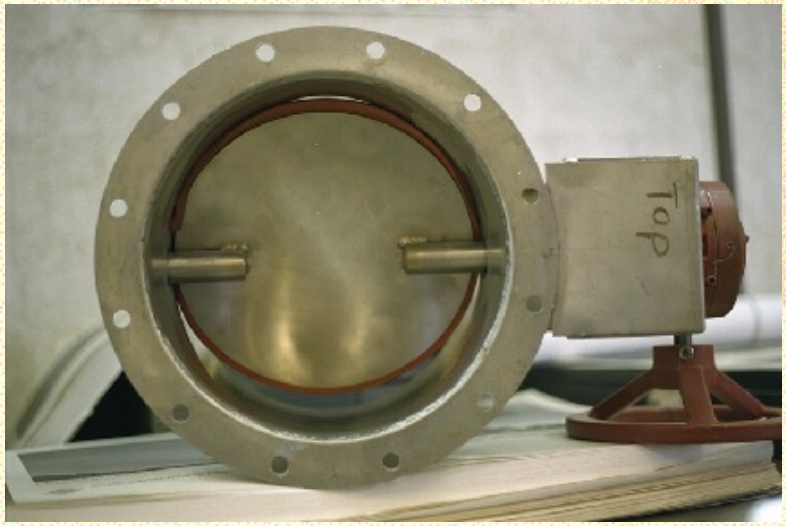
- Clearance space around equipment to facilitate maintenance and removal

Lighting and Power Supplies

- Adequate lighting level
- Availability of electrical power supply at the proper voltage

Isolation

- Decontamination for program requirements



Component Limitations

- **Knowledgeable of the components or system limitations**

Indicators or Monitors

- **Maintain constant one directional air flow all time**

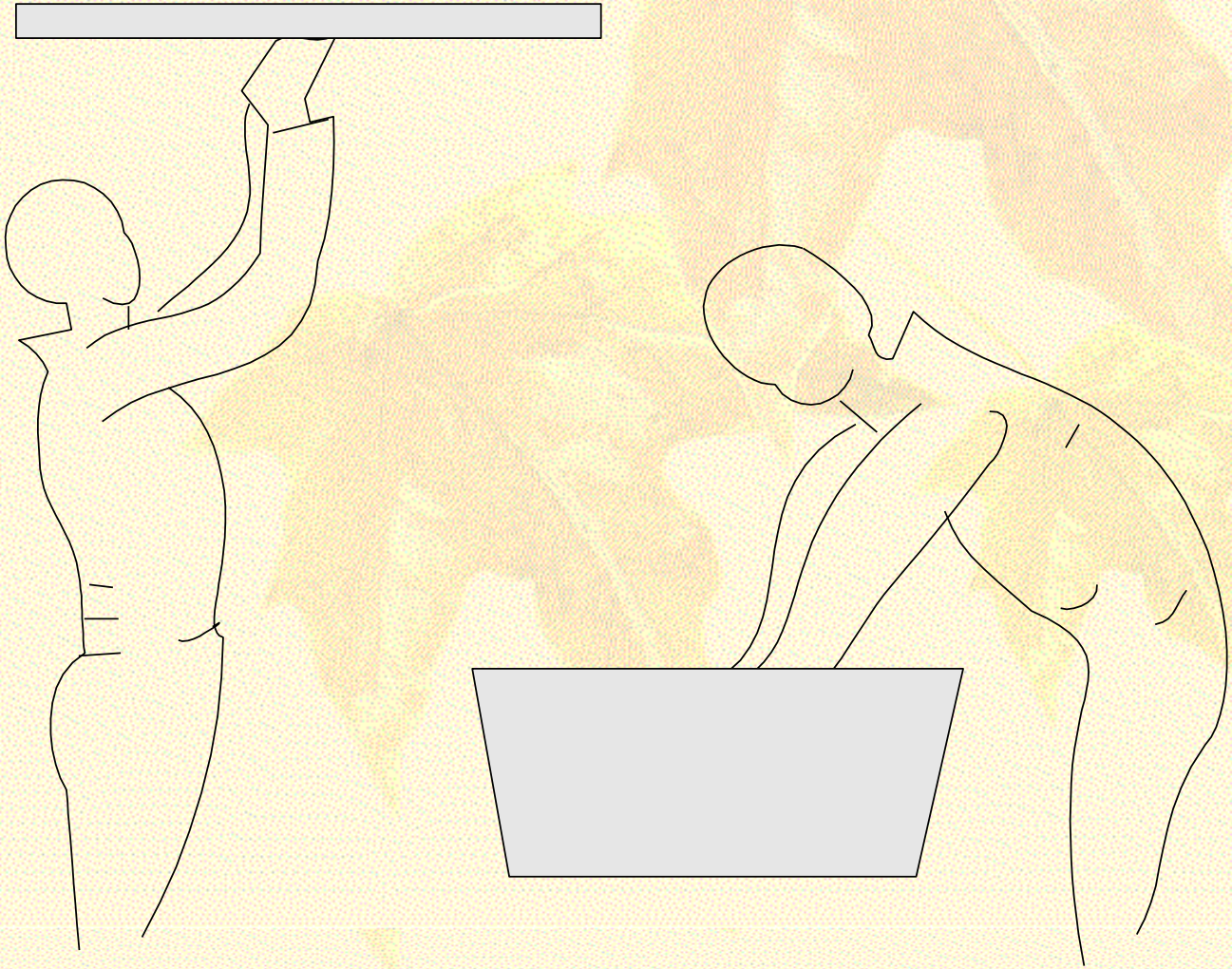
Human Engineering

- Criteria used for design and development of systems and components
- Enhance required performance by maintenance staff
- Improve system reliability
- Minimize training time and skill requirements

Human Factors

- Positions to perform a task must be evaluated, particularly precision is required
- Adequate positions (height, platform) to allow a precision operation:
  - Fatigue, efficiency compromised and thus mistake

Human Factors



Human Factors

- **Adequate height**

Redundancy

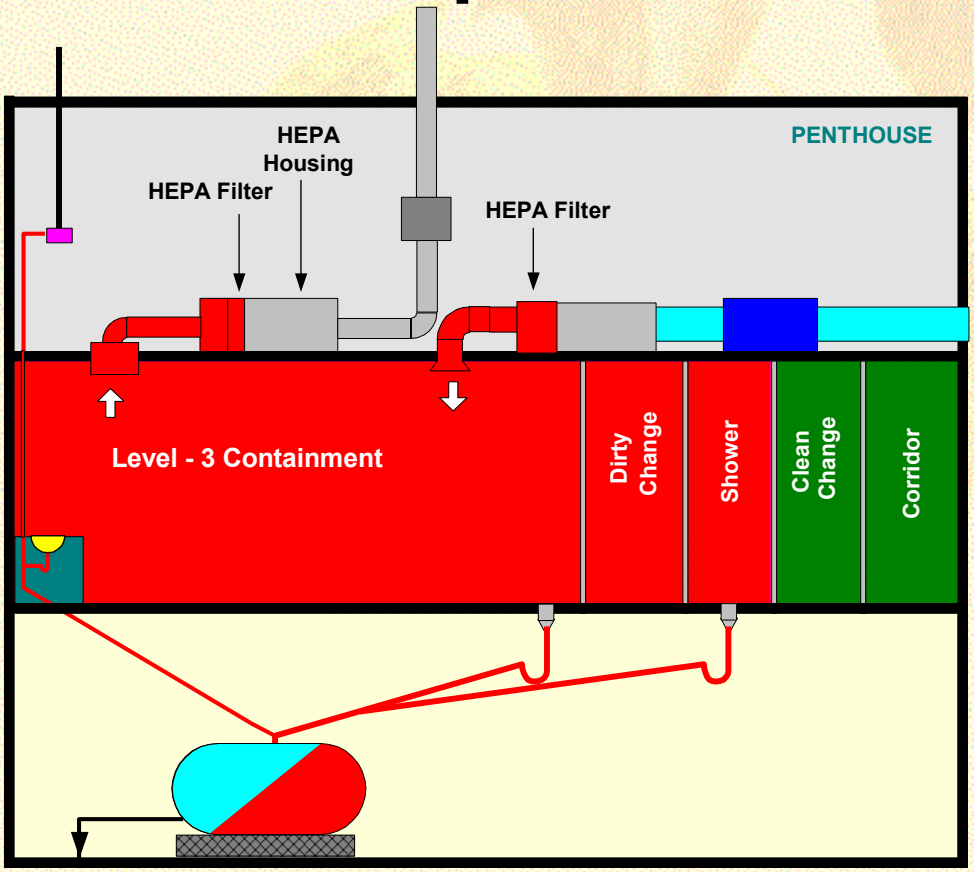
- **Parallel operation**

Redundancy

- Spare parts

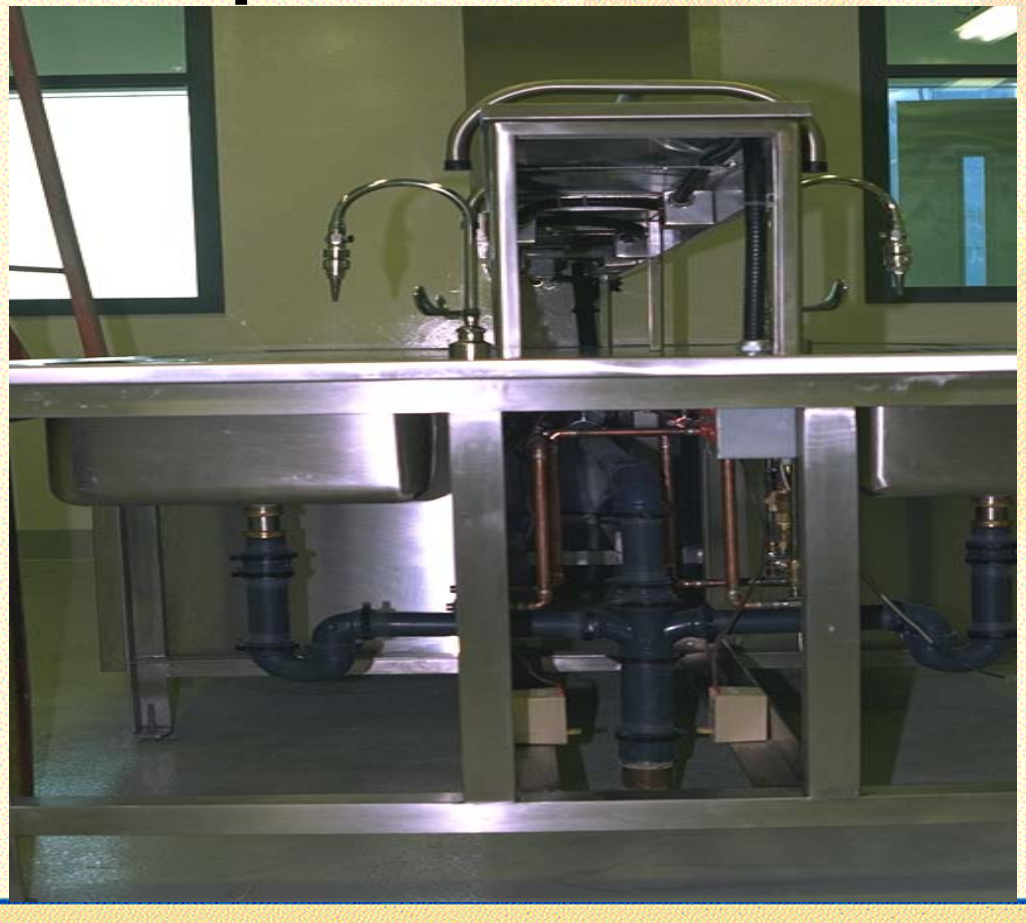
Contamination

- Minimization of potentially contaminated space



Inspection and Testing

- All piping to be exposed for test and inspection



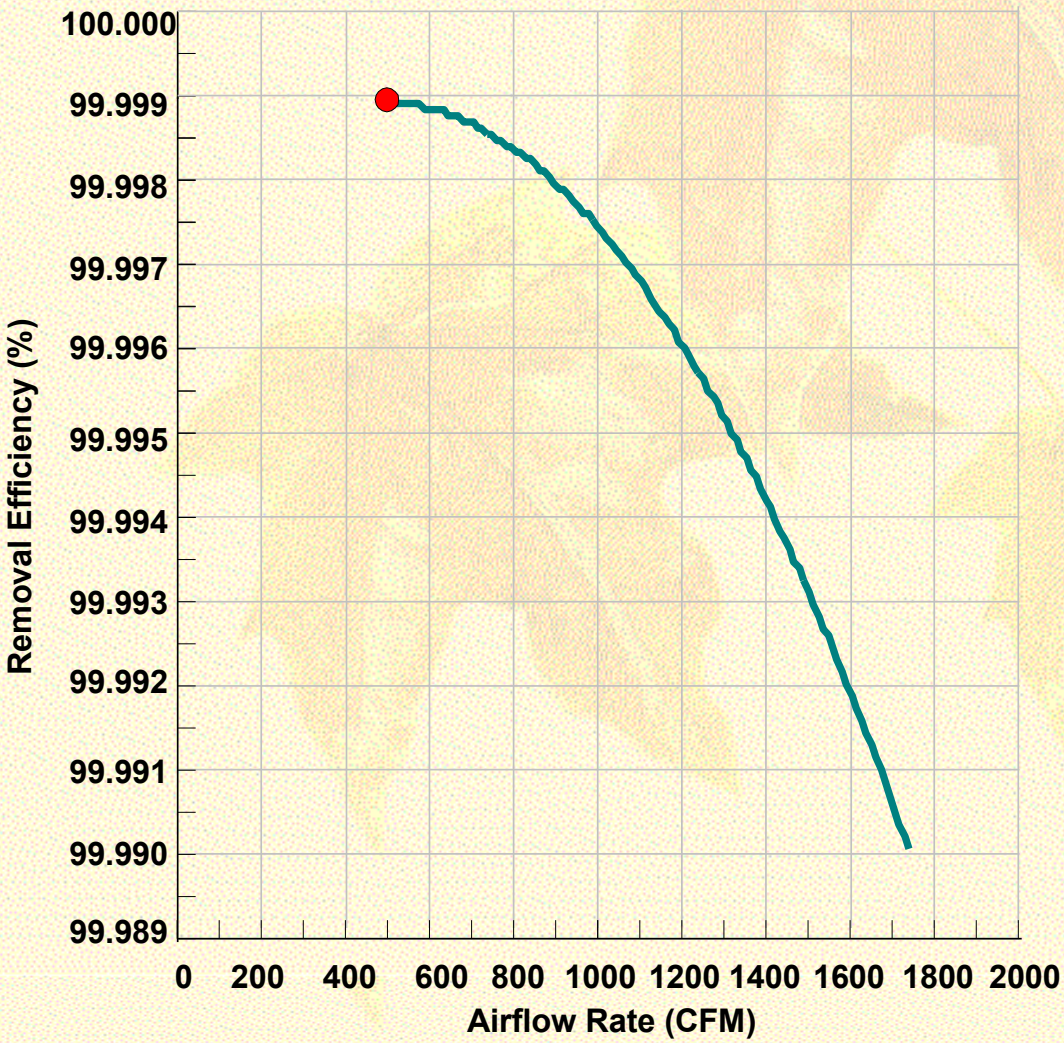
Maintenance Frequency

- Reduction of frequency of maintenance of equipment and components

Underrating Filters

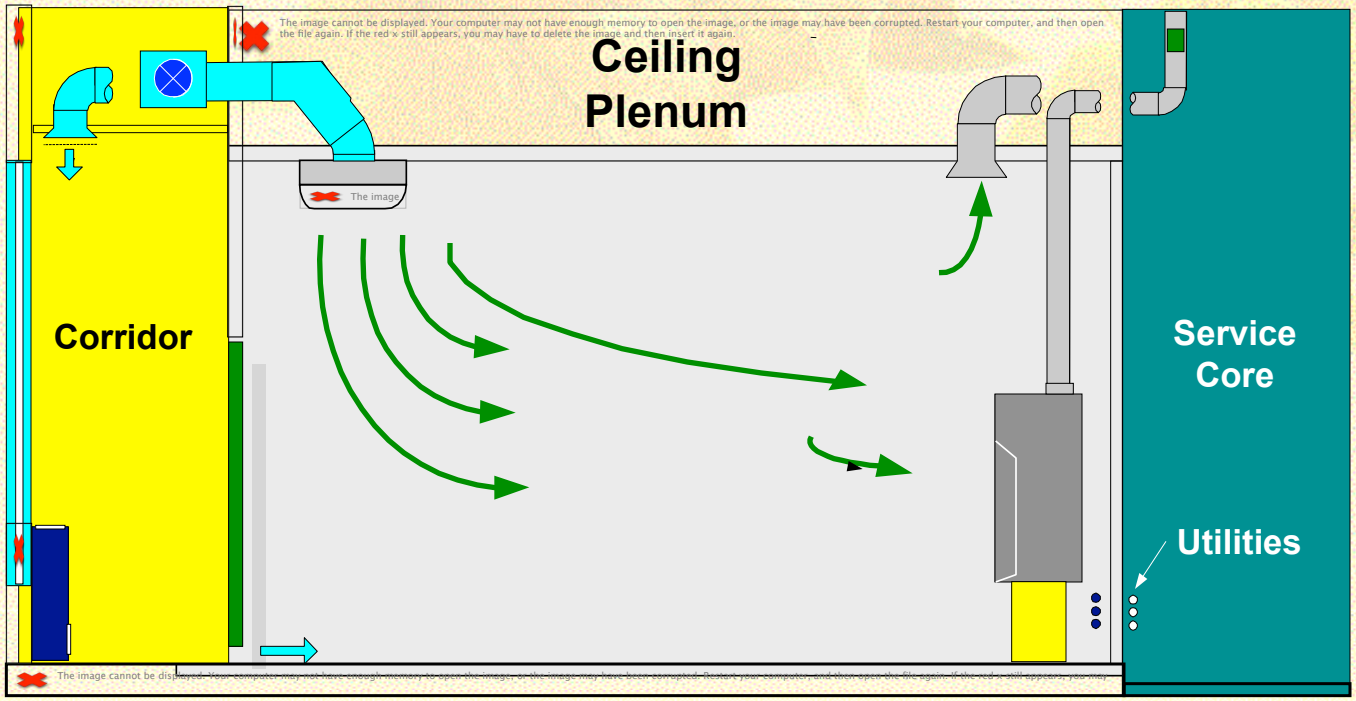
- Energy efficiency improvement by underrating filters and extending their useful lives and thus the reduction of frequency of testing, decontamination and certification

Underrating Filters



Minimizing Interference

- Components require services shall be located away from lab spaces



Minimizing Interference

- Locate equipment that requires maintenance outside lab space

Gauges

- Installing prefilter for HEPA filter and a dedicated gauge for each filter

Limited Space

- Custom-made units

Standardization

Reduce down-time

Minimize spare parts

Less training for in-house maintenance staff

Less training for outsourcing staff

Manuals

- Designers to produce O&M manuals – architectural, mechanical, electrical, control, security, etc
- Standard operation protocols (SOPs) for the various modes of operation:
  - Regular
  - Emergency
  - Decontamination
  - Fumigation
  - Others

Maintainability

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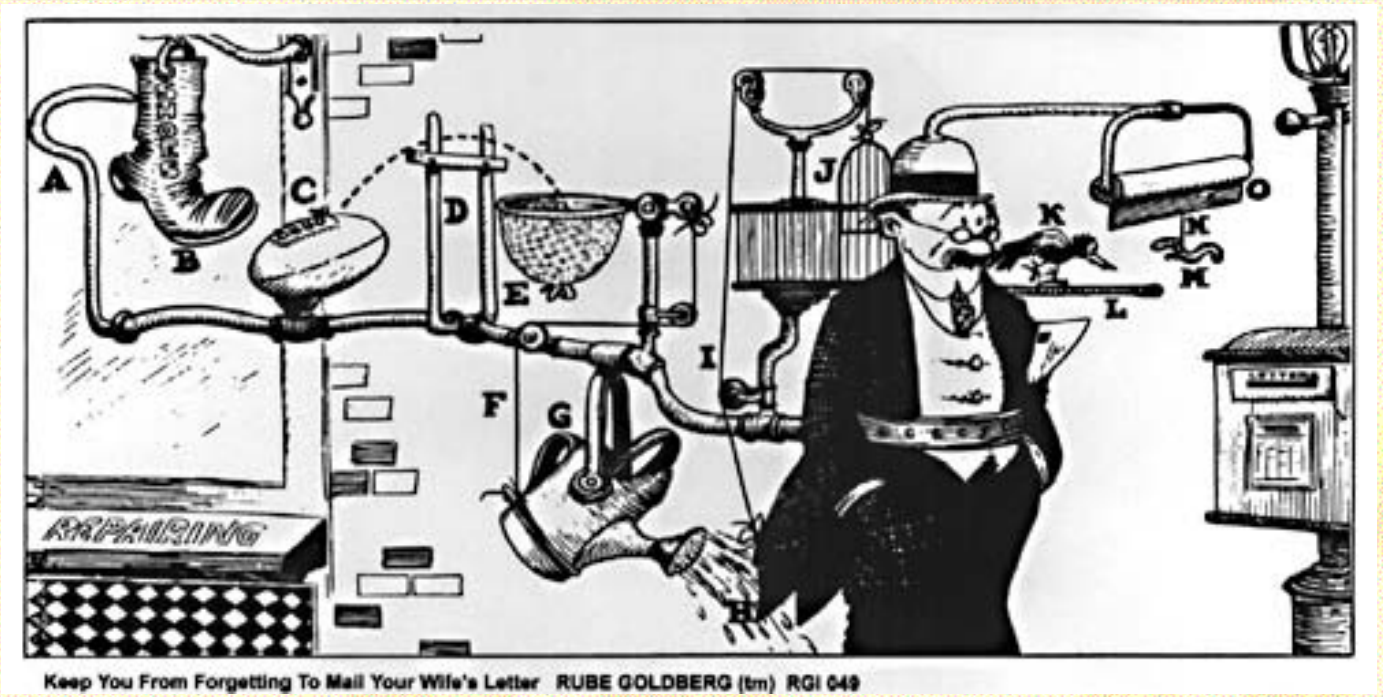
Rube Goldberg



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- Don't complicate systems with controls or strategies – costly to install and maintain
- Use protocols to achieve the same

Thank You!!