AG-1 and Robust HEPA Filters

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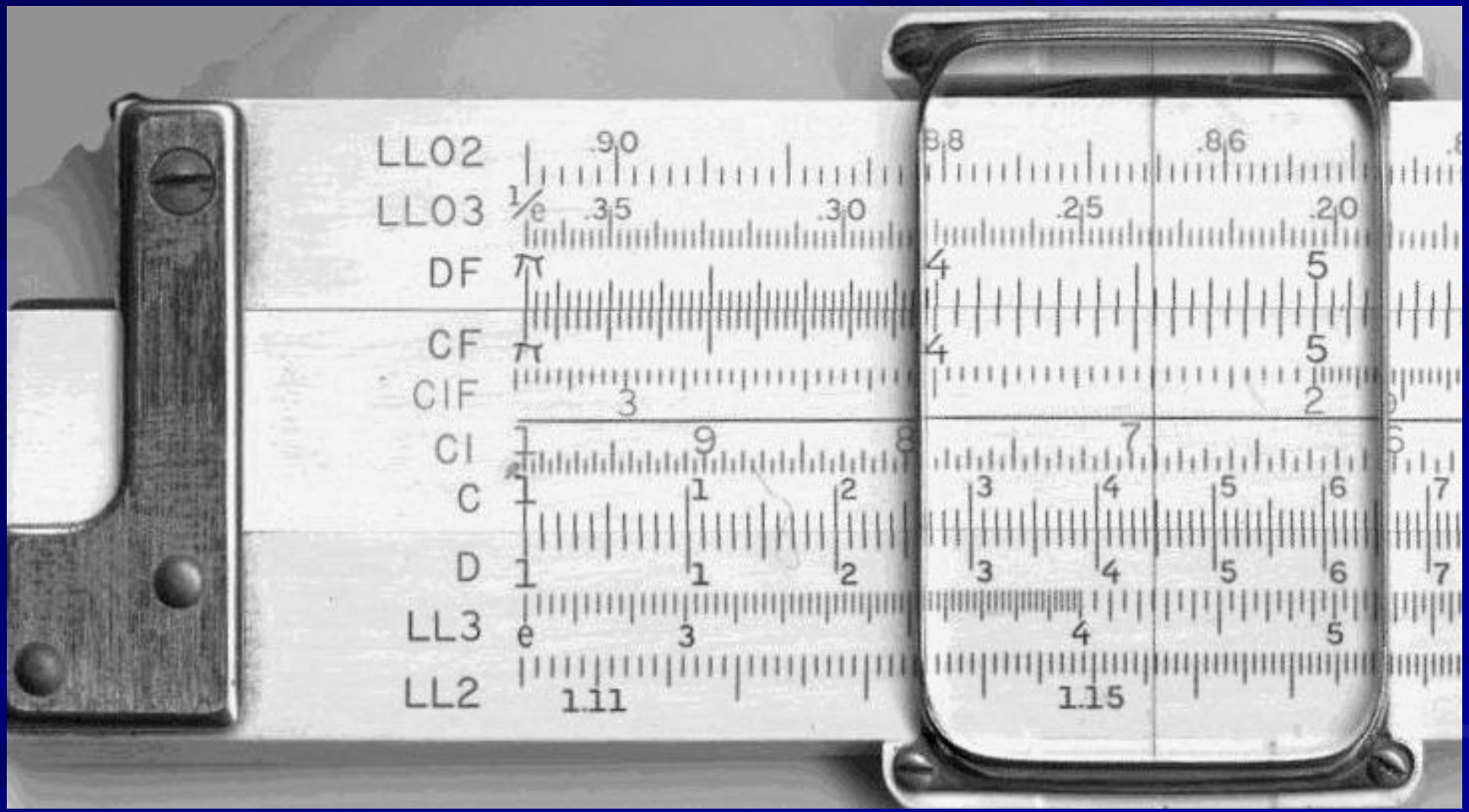
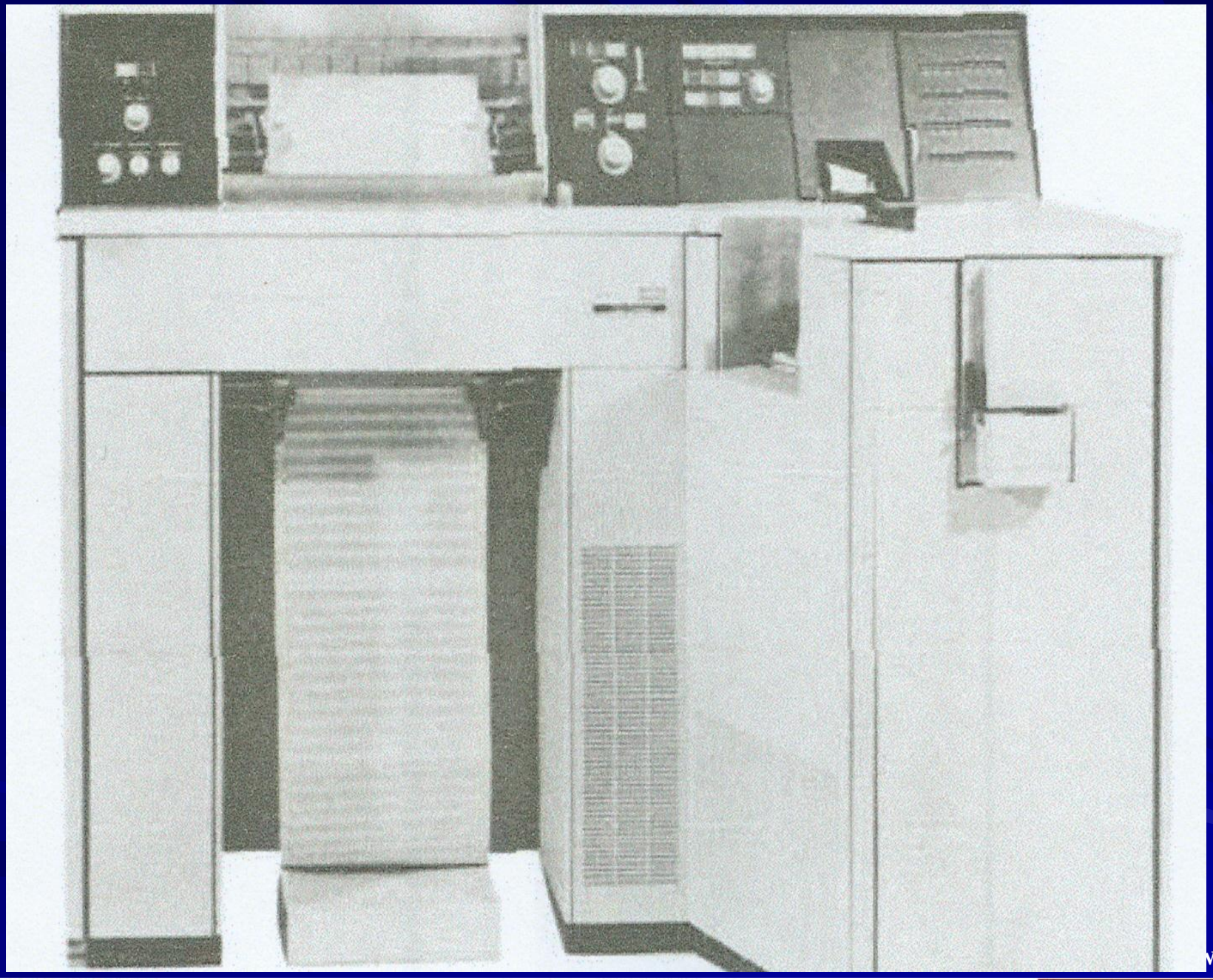
Technology of the 1950s





Technology of the 1970s

Heritage

- Aerosol Mechanics – Langmuir, Einstein
- Containment Ventilation – Gilbert, Anderson, First, Bergman, Kovach
- Texts – Hinds, Baron and Willeke, Fuchs
- Workshops & Seminars – Minnesota, Harvard

Filtration Guiding Principles (FC Design Requirements)

- HEPA Filtering Efficiency 99.97%
  - <300 nm, MPPS
- Maximum Media Velocity of 5 ft/min
  - Loading Capacity
- Maximum Initial dP of 1.0 in. w.c. (1.3)
- Maximum dP 4 to 6 in. w.c.
- Maximum Sustained T of 250 F

Qualification Testing

- Initial dP
- FE
- Resistance to Pressure
- Resistance to Temperature
- Spot Flame
- Rough Handling

Technology Has Changed

- No Longer Add Asbestos Fibers to Medium to Increase Filter Efficiency
- Fibrous Glass Medium can be Laid Down on Woven Fabric Backing
- Stainless Steel can be Drawn to 2 um Wires
- Chemically Resistant Metal Powder can be Sintered into Cylindrical Elements
- High Temperature Ceramic Membranes

Filter Type (flow)	Medium	Max Media Velocity (ft./min)	Rated Flow (scfm)	Initial dP (in. w.c.)	Max dP (in. w.c.)	Max T (F)
FC with separator (axial)	FG	5	1000	1.0	4.0-6.0	250
FC with separator (axial)	FG	5	1250	1.0	4.0-6.0	250
FC with separator (axial)	FG	5	1500	1.3	4.0-6.0	250
FC with separator (axial)	FG	5	2000	1.3	4.0-6.0	250
FC separator less (axial)	FG	5	1000	1.0	4.0-6.0	250
FC separator less (axial)	FG	5	1500	1.3	4.0-6.0	250
FK (radial)	FG		2000	1.3	4.0-6.0	250
FL (vertical)	Sand	As designed				

Sections Under Development

Filter Type (flow)	Medium	Max Media Velocity (ft./min)	Rated Flow (scfm)	Initial dP (in. w.c.)	Max dP (in. w.c.)	Max T (F)
FI (axial)	SM-F	User defined				
FI (radial)	SM-F	User defined				
FI (radial)	SM-P	User defined				
FK (radial)	FG-R	5	2000	1.3	225	250
FK (radial)	FG-2R	5	2000	1.3	225	250
FM (axial)	FG-R	5	1000	1.3	40 - 100	250
FM (axial)	FG-2R	5	1000	1.3	40 - 100	250
FO		User defined				

Section FM Qualification

- Sequential Testing of Individual Filters
- Levels of Qualification
  - Level I – 5 psig Impulse
  - Level II – 10 psig Impulse
  - Level III – 20 psig Impulse
- Robust Filters Require Progressively Intense Qualification
- Qualification by AG-1 not the Customer

Performance Level Qualification

- Current Tests for Level 1 Filters
- Add Loading Test to 20 in. w.c. dP for Level 1 Filters
- Level 2 and 3 Filters Undergo Sequence of Tests
- DBE Conditions for Level 2, SA Conditions for Level 3 Filters
- Project Teams Adapt Tests to Strengths and Weaknesses

Level 2 and 3 Qualification

- Generic DBE Challenge Conditions
  - Temperature
  - Relative Humidity
  - Media Velocity
  - Particle Size Distribution
  - Aerosol Chemistry
- Project Team Specifies Conditions

Air Filtration Theory has not Changed, Technology Has

Filter Type (flow)	Medium	Max Media Velocity (ft./min)	Rated Flow (scfm)	Initial dP (in. w.c.)	Max dP (in. w.c.)	Max T (F)
FI (axial)	SM-F	User defined				
FI (radial)	SM-F	User defined				
FI (radial)	SM-P	User defined				
FK (radial)	FG-R	5	2000	1.3	225	250
FK (radial)	FG-2R	5	2000	1.3	225	250
FM (axial)	FG-R	5	1000	1.3	40 - 100	250
FM (axial)	FG-2R	5	1000	1.3	40 - 100	250
FO		User defined				

Dr. Kovach, I'll take your questions first, then Dr. Bergman's.