Tracking the Performance of your Membranes Using the MEMboard Database System

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ready for the resource revolution

SUEZ

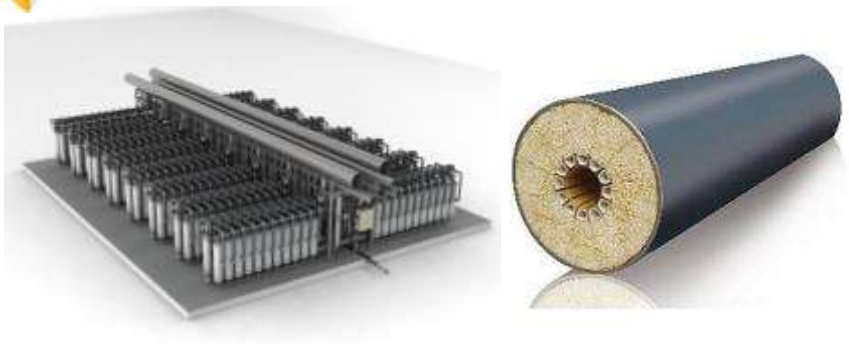
Contents

CONTEXT

Ultrafiltration membranes for potable water treatment

Advantages of low-pressure membrane technology…

- High bacteria & virus removal efficiency
- Small footprint
- Low chemical consumption

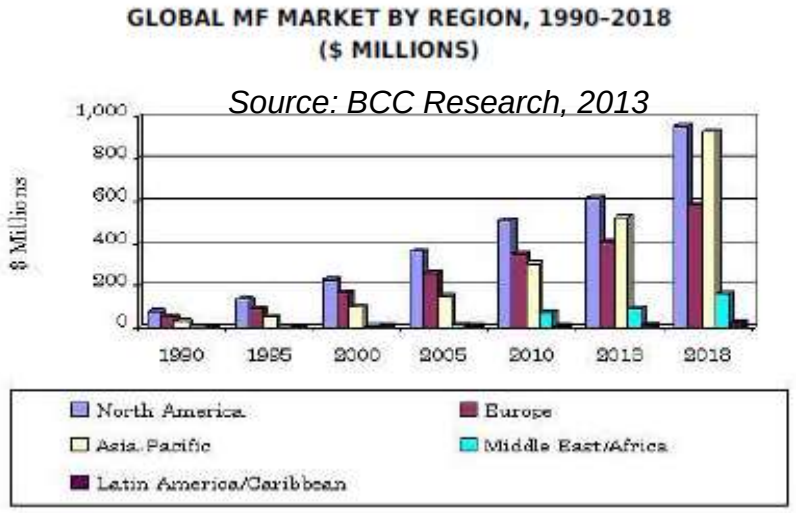


… about to become the **Best Available Technology** with the lowest cost for clarification & filtration applications

Source: Pierre Côté, 2012

Drivers for market growth in the U.S.

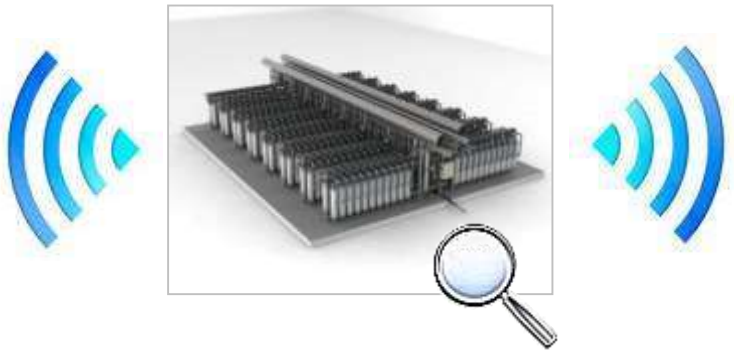
- Diminishing options for increasing freshwater supply
- Increasingly stringent DW regulations
- Need to replace/upgrade older treatment systems



Source: BCC Research, 2013

Context

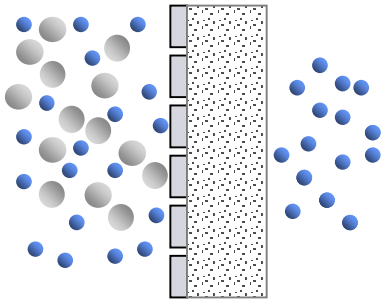
Challenges related to membrane operation



- The **nerve center**
- A **precious asset**

Membrane systems

1. Fouling



2. Integrity failures

3. Ageing

1. Prevent membrane fouling
2. Maintain membrane physical barrier integrity
3. Preserve membrane from premature aging

CONTEXT

Columbia Water Treatment Plant ID card

- **Source of supply:** Boise River
- **Capacity:** 6 MGD
- **Membrane units:** 6 skids of 112 modules each
- **Membranes:** Pressurized Memcor PVDF modules

- **Drivers:**

Meet the **increasing demand** in Idaho's rapidly growing capital city

Lessen dependence on ground water while allowing the **aquifer to recharge**

Meet & exceed Current Quality Regulations (Idaho Department of Environmental Quality and U.S. Environmental Protection Agency (USEPA) drinking water quality standards)

CHALLENGES

- **Protect the membrane investment**
- Achieve **continuous and reliable performance**
- **Extend the membrane lifespan**

CONTEXT

Columbia Water Treatment Plant

View of Columbia WTP skid during membrane module replacement

Contents

What is MEMboard ?

A smart tool for MF, UF & RO membrane asset management

BEFORE

- Data stored in handwritten logsheets hard to handle & compile

- Membrane replacement not optimized

NOW MEMboard

Complementary to SCADA

A web-based software to Document and Report O&M Activities*

- User-friendly interfaces
- Mapping of module conditions
- Cradle-to-grave membrane tracking
- Not only a stock manager but for all key manual checks
- Decision making to optimize module replacement schedule

** Module loading/unloading/ replacement*
Water quality control in/out
Manual control of the normalized operating data
Inspections, (cassettes of MBR, RO pressure vessels)
Control of membrane integrity / MF& UF fiber repairs
Control of cleaning efficiency & preservative solutions

WHEN DOES MEMBOARD MAKE SENSE?

A single tool providing data management to:

1 Large facilities

- Manage large amount of information with a user-friendly tool
- Potentially big savings by postponing module replacement

2 Small & scattered facilities

- Centralize data
- Coordinate the maintenance of different membrane technologies
- Compare trends

3 Facilities experiencing failures

- Take a step back from day-to-day operation to diagnose issues (fouling, integrity failure, etc.) & proactively solve them
- Provide clear information for warranty claims

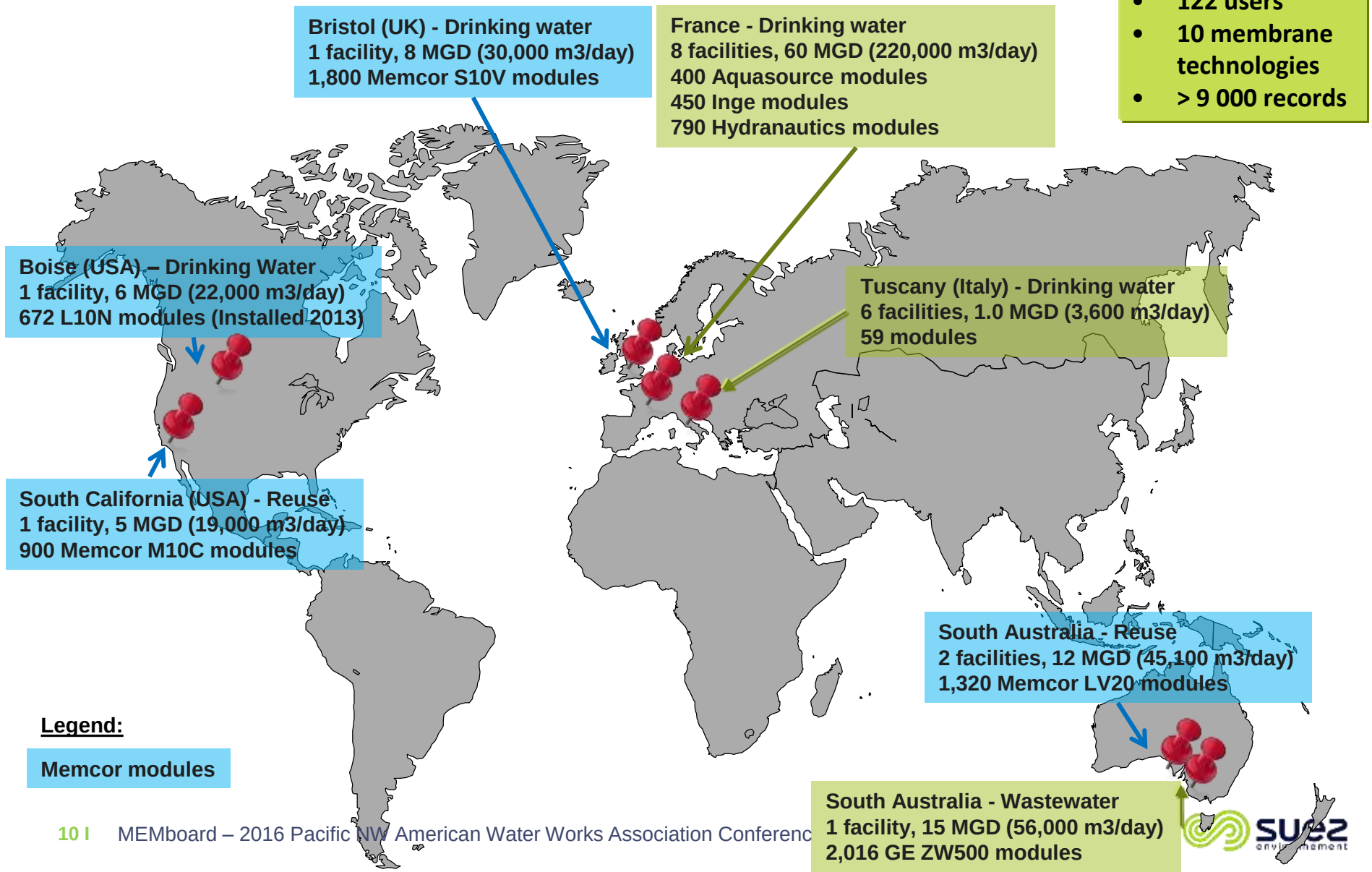
4 Facilities in “hibernation”

- Preserve membrane service life despite long-term conditioning
- Avoid premature ageing by controlling preservative solution

MEMBOARD IN USE AROUND THE WORLD

References since 2013

- 20 facilities
- 122 users
- 10 membrane technologies
- > 9 000 records



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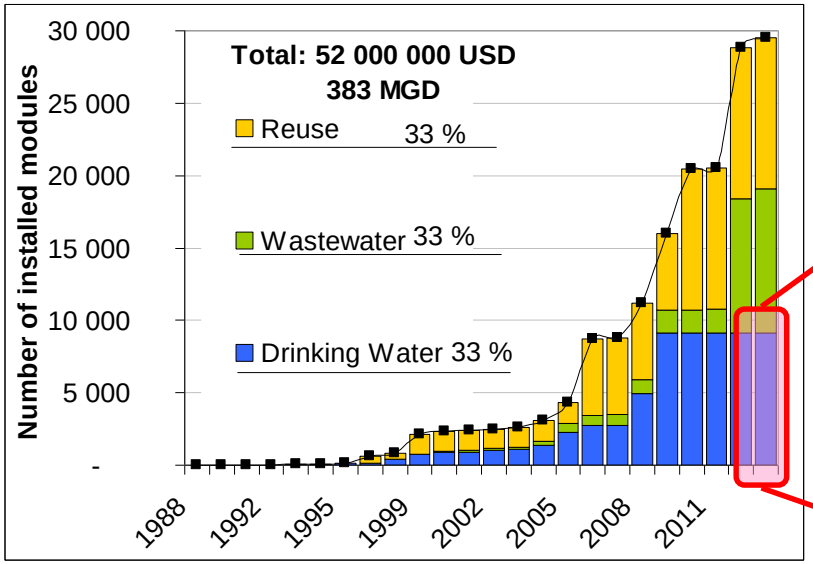
SURVEYED MEMBRANE INSTALLATIONS

Plant	A	B	C	D	E
Capacity (MGD)	24	16	15	11	3
Inlet water	Filtered	Clarified	Filtered + PAC		
Membrane configuration	PDI	SUB	PDI		
Technology	a	b	c	d	
Membrane area (m²)	36 500	62 800	14 400	15 000	7 500

Membrane installations operated by SUEZ



DWTP sample

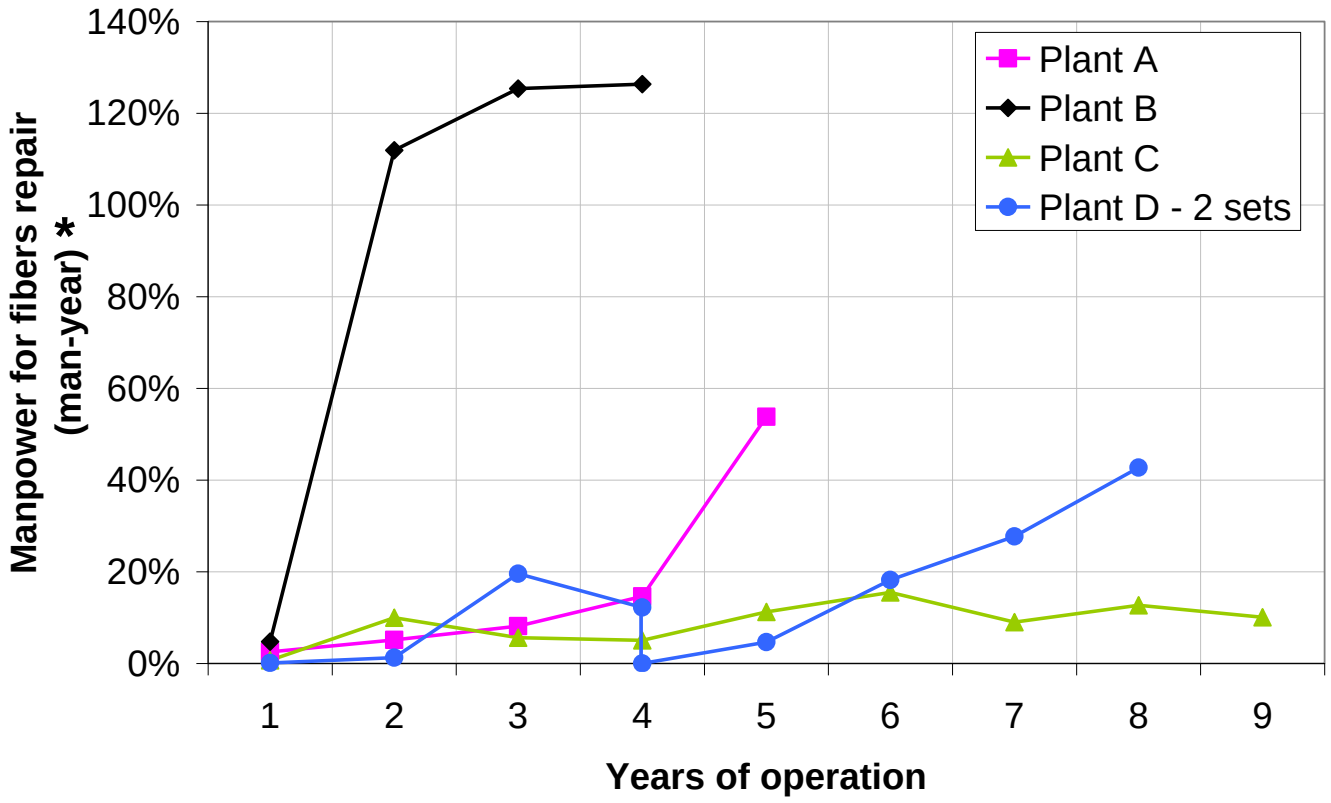
Biggest plants

Nb of plants	32 plants
Production capacity	0.02 to 24 MGD
Nb of years of operation	1 to 11 years (average: 3 years)
Nb of membrane technologies	5
Raw water (% of total capacity)	- Surface water: 80 % - Groundwater: 20 %

Legend: - PAC: Powdered Activated Carbon
- PDI: Pressure Driven Inside Out
- SUB: Submerged

LESSON LEARNED

#1: Inadequate pre-filters can lead to premature fiber failures



- In the absence of pre-filters at Plant B, labor required for fiber repair is **6 times more intensive** than at other plants

* Based on a repair cost for a broken fiber event on a module of $70 (Freeman, 2012)

LESSON LEARNED

#1.1 Columbia WTP Pre-filters (Strainers)

To protect the membrane modules, and comply with warranty requirements, the existing 500 micron strainers were replaced with 250 micron strainers

Existing duplex strainer assembly

Retired 500 micron strainers

LESSON LEARNED

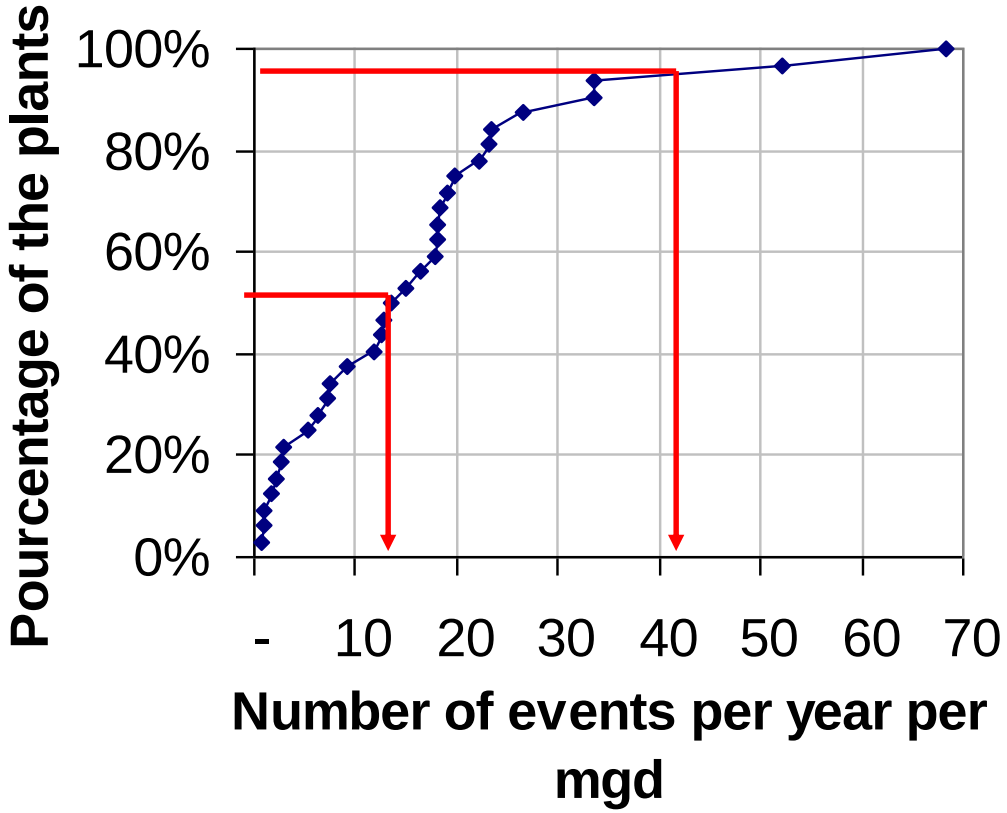
#2: Gradual heating of the chemical cleaning solution will avoid membrane damage

Plant	A		C	
Water heating for cleaning	No		Yes	
Season	Summer	Winter	Summer	Winter
Water temperature (°C)	Max: 26°C	Min: 3°C	Max: 25°C	Min: 4°C
Nb of broken fibers per season	623	543	396	562
Winter-Summer broken fibers factor		0.8		1.4

- In the absence of gradual heating, fiber breakage on Plant C increases by a **factor of 1.4** in winter compared to summer

LESSON LEARNED

#3: Do not neglect the workload required for membrane repair



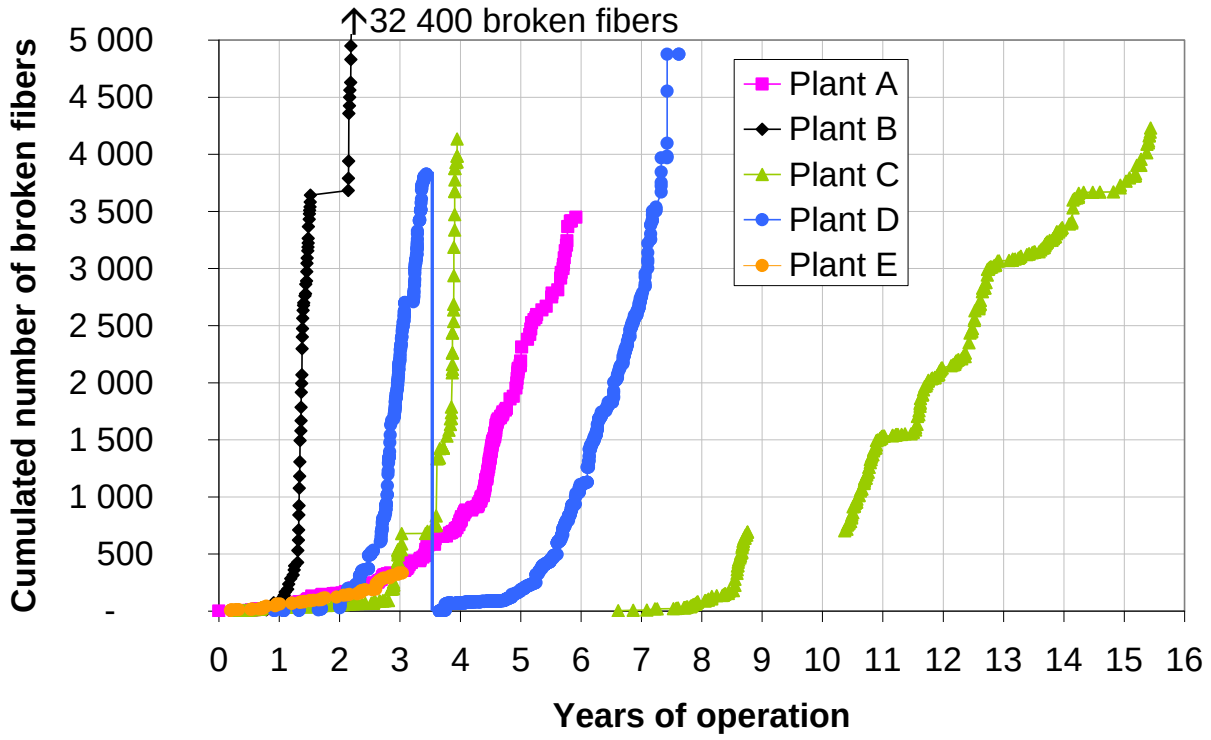
Per year per mgd	Present survey	Freeman (2012)
Weighted average	**14** repair events ⇔ 980 USD*	**12** repair events ⇔ 840 USD*
95 percentile	**42** repair events ⇔ 2 940 USD*	**81** repair events ⇔ 5 670 USD*

* Based on a repair cost for a broken fiber event on a module of 70 USD (Freeman, 2012)

- A significant effort is required for membrane integrity control, module isolation, broken fiber detection and repair

LESSON LEARNED

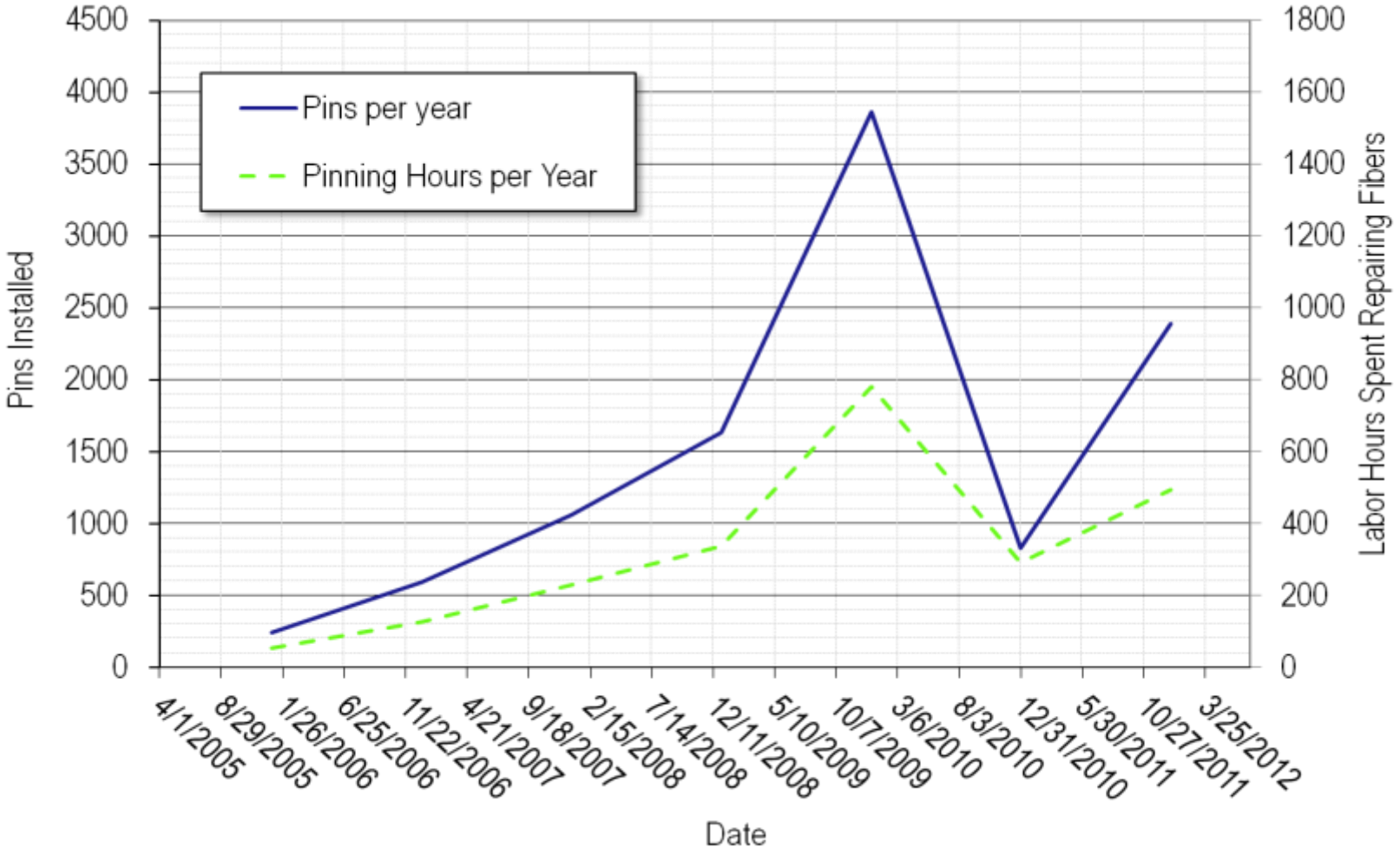
#4: Anticipate increase of manpower required for fiber repair



- Workload for fiber repair is **exponential**
- Membrane aging trend is generally **reproducible** from one module load to another (Plant D)
- When membrane replacement is spread out over years, the cost trend is flattened **with time** (Plant C)

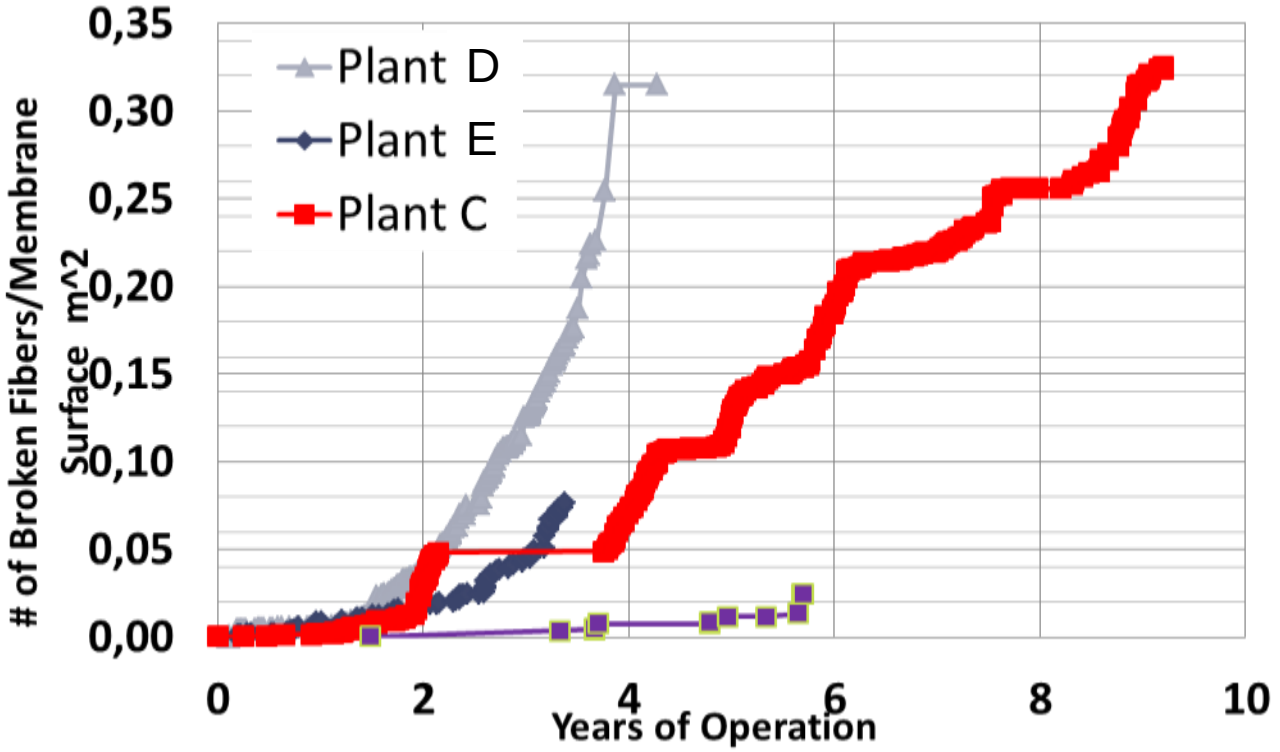
LESSON LEARNED

#4.1 COLUMBIA WTP HISTORY OF FIBER BREAKAGE – 1ST GENERATION



LESSON LEARNED

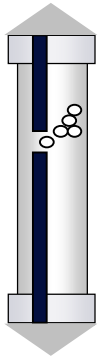
#5: Compare trends between different plants with the same technology



Detection of abnormal fiber breakage pattern on Plant D

LESSON LEARNED

#6: Keep in mind that the membranes are a precious asset



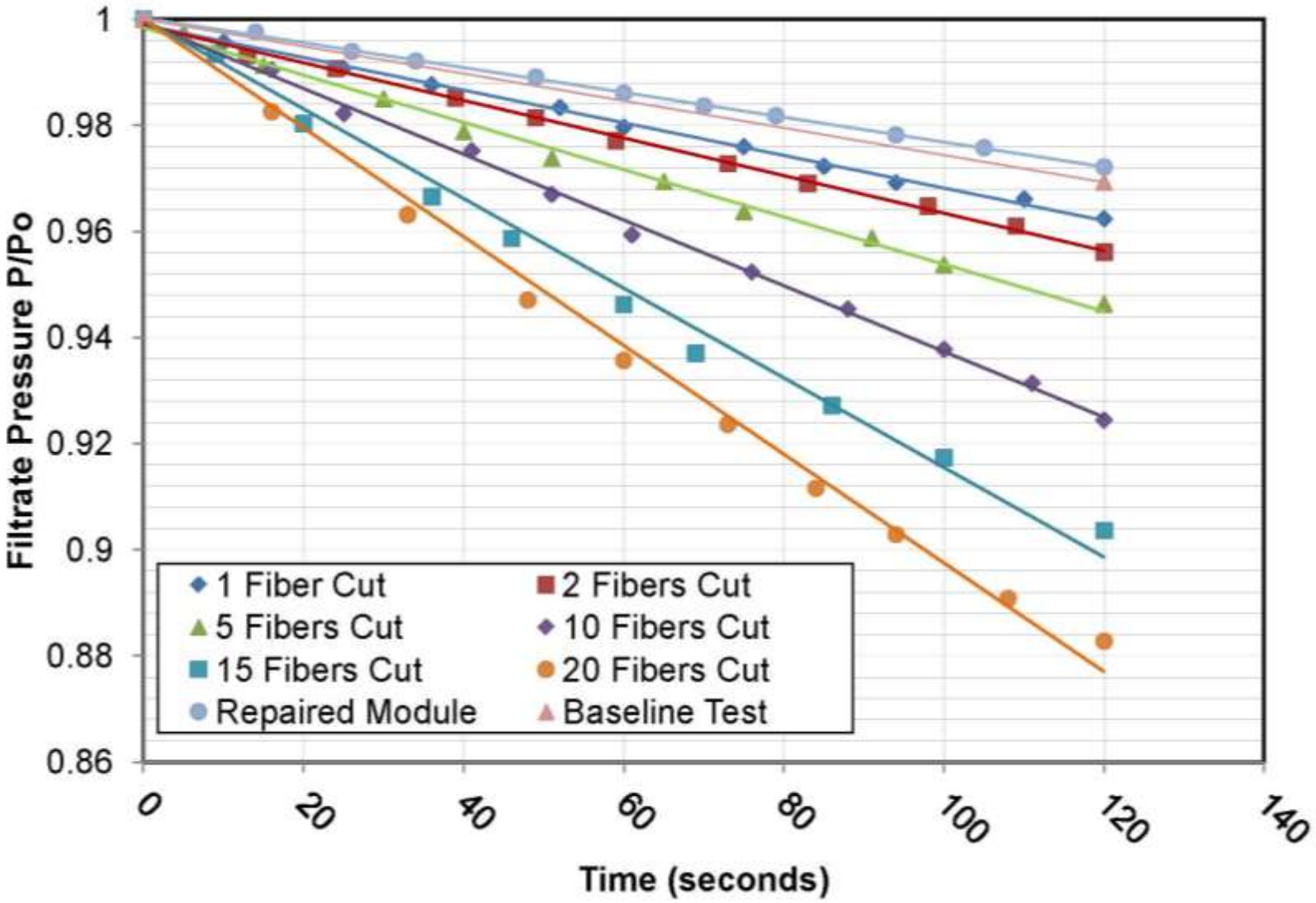
Plant	A	B	C	D	E
Membrane configuration	PDI	SUB	PDI	PDI	PDI
Membrane area (m^2)	36 500	62 800	14 400	15 000	7 500
Annual modules replacement cost ($)	$564 000	$315 000	$223 000	$223 000	$96 000
Number of events per year per MGD	10	69	4	24	16
Annual fiber repair cost ($)*	$16 800	$77 280	$4 200	$18 480	$3 360
Fiber repair cost / modules replacement cost	**3%**	**25%**	**2%**	**8%**	**3%**

- Even if the required effort for fiber repairs is big, its cost is much lower than the **cost of the membrane asset**

* Based on a repair cost for a broken fiber event on a module of $70 (Freeman, 2012)

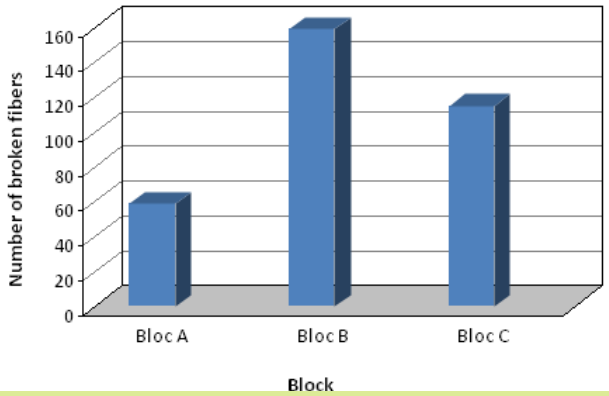
LESSON LEARNED

#6.1: Keep in mind that the membranes are a precious asset – Integrity Test Validation; Columbia WTP 2013 module replacement

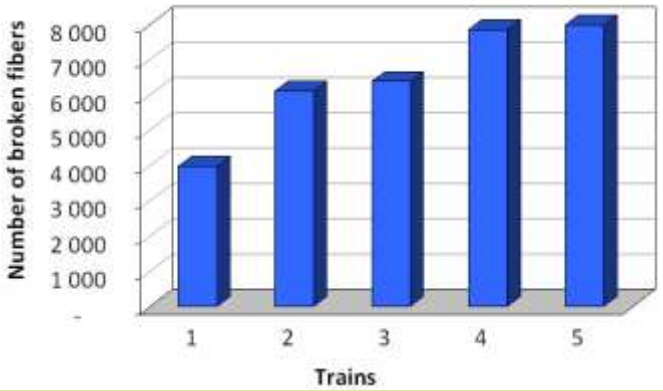


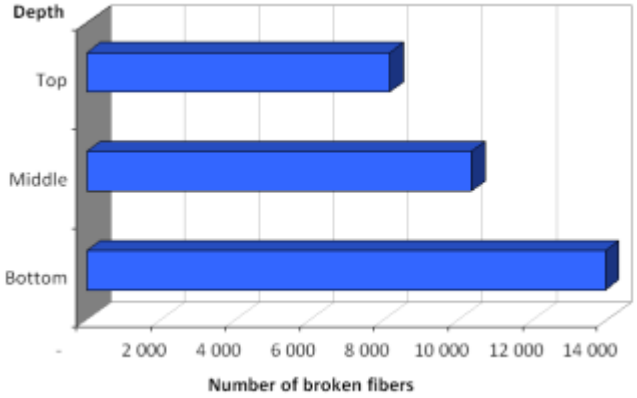
LESSON LEARNED

#7: Take a step back by looking at the overall picture



- Plant E: **Preferential zone** of fiber breakage on block B is explained by its location near the entrance of the backwash water pipe





- Plant B: **Gradual distribution** of the broken fibers corresponding to the inlet flow direction (from trains 5 to 1) & to the depth in the tanks (settled particles & higher aeration rate during backwash at the bottom)

LESSON LEARNED

#8: Use this valuable information to anticipate best replacement schedule

By knowing:

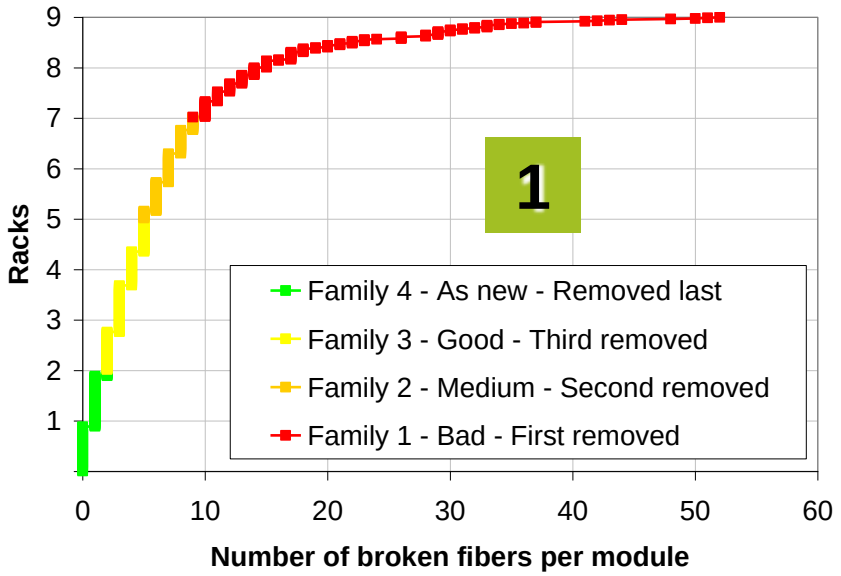
- The exact number of broken fibers for every modules
- The trend of the average number of broken fibers per module

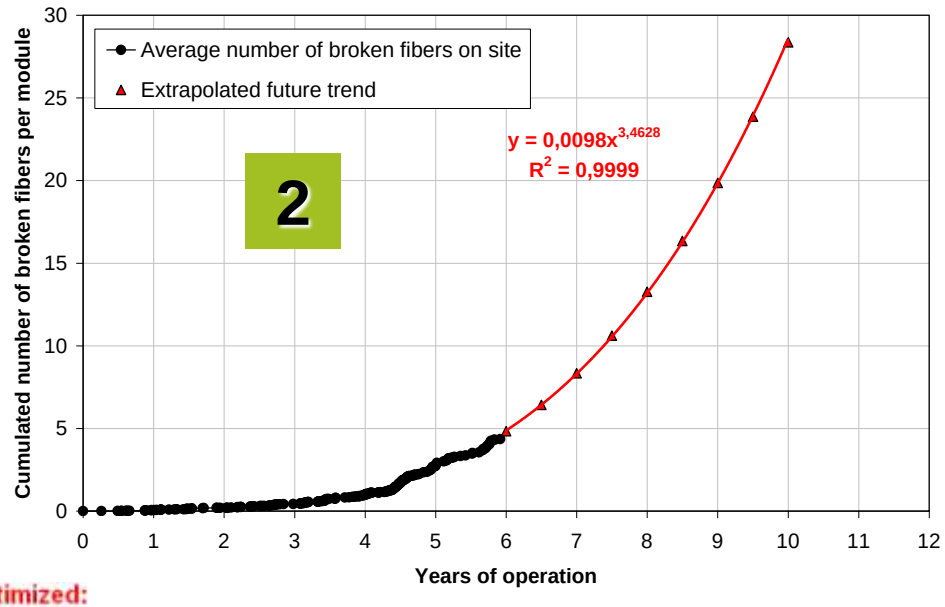
Strategy:

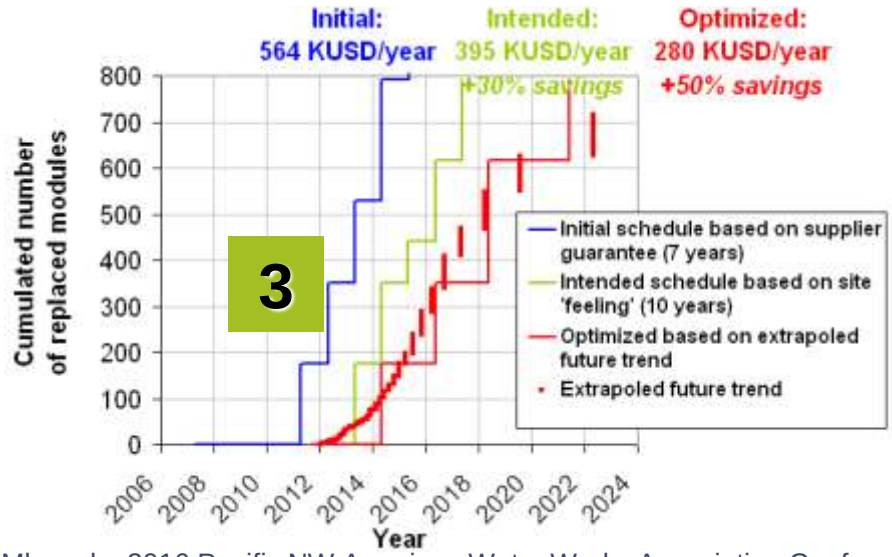
- Define **families of modules** by gathering them by packs (1 pack = 1 or more entire unit);
- Plot the **trend of fiber breakage** for the coming years for each module by extrapolation;
- By applying this breakage rate on each module, **plan their replacement** when they reach a maximum number of broken fibers (generally based on the maximum acceptable manpower required for fiber repairs)

LESSON LEARNED

#8: Use this valuable information to anticipate best replacement schedule







Plant A: savings on the annual module replacement cost:

- **30%** compared to the intended schedule
- **50%** compared to the initial schedule

Contents

CONCLUSIONS

- The MEMboard system for tracking membrane p**erformance is in use at plants around the world and** at the Columbia WTP in Idaho

- The system:
  - Enables users to track membrane module performance and **predict replacements/failures**
  - Is intended to **save money** on membrane replacements by tracking each module from cradle to grave. This permits operators to replace only those modules that are failing
  - Tracks and trends **clean-in-place performance** and other plant parameters
  - Permits **direct comparison of results** from similar membrane systems across the globe

- The efficient and effective performance of membranes is v**ital to the protection of public health**
- Keeping these assets **in top condition** is important

Appendix

Screen shots

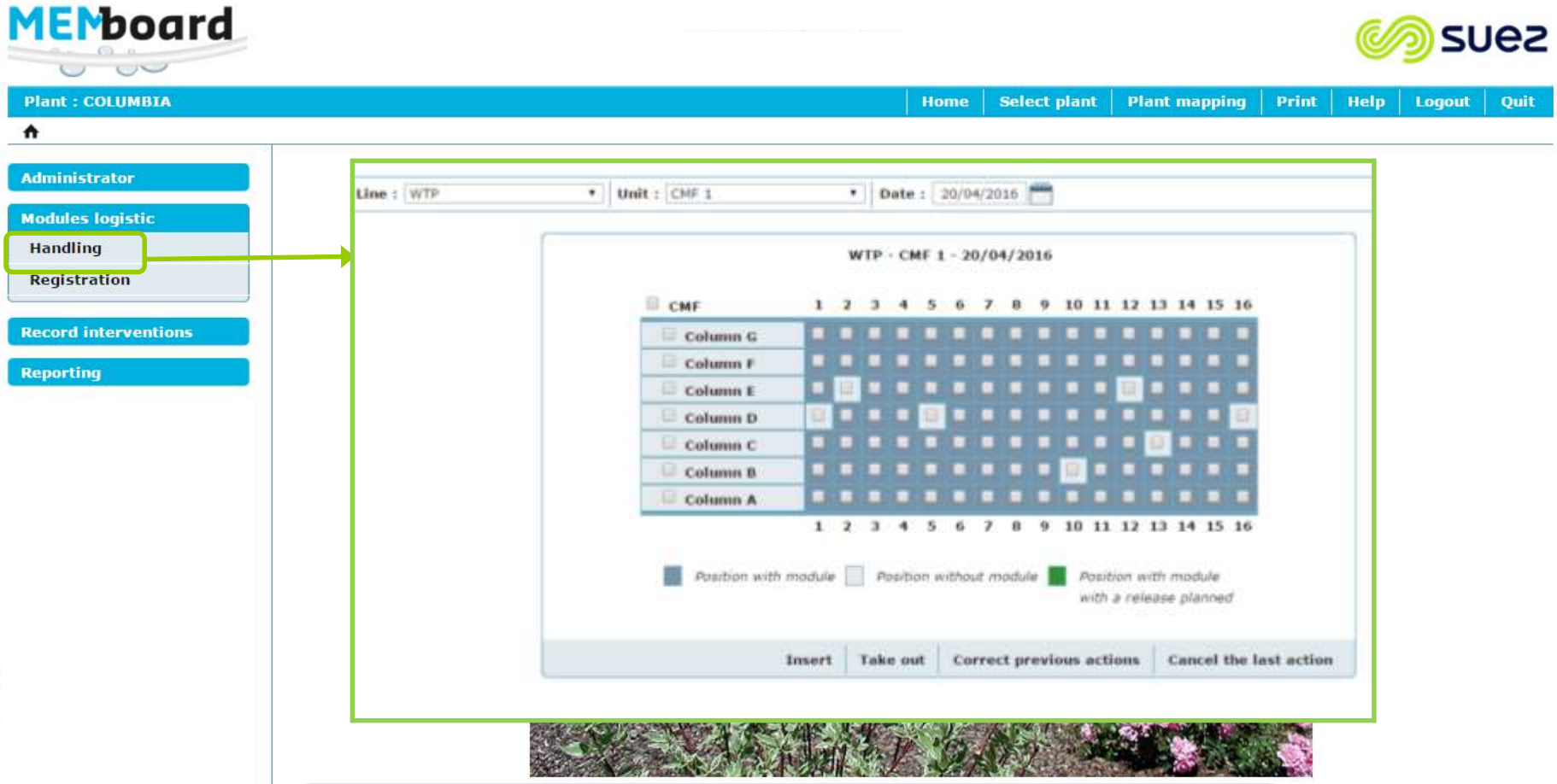
Screen shots

Home page

Access to 1 or several plants

Plants mapped in 5 levels

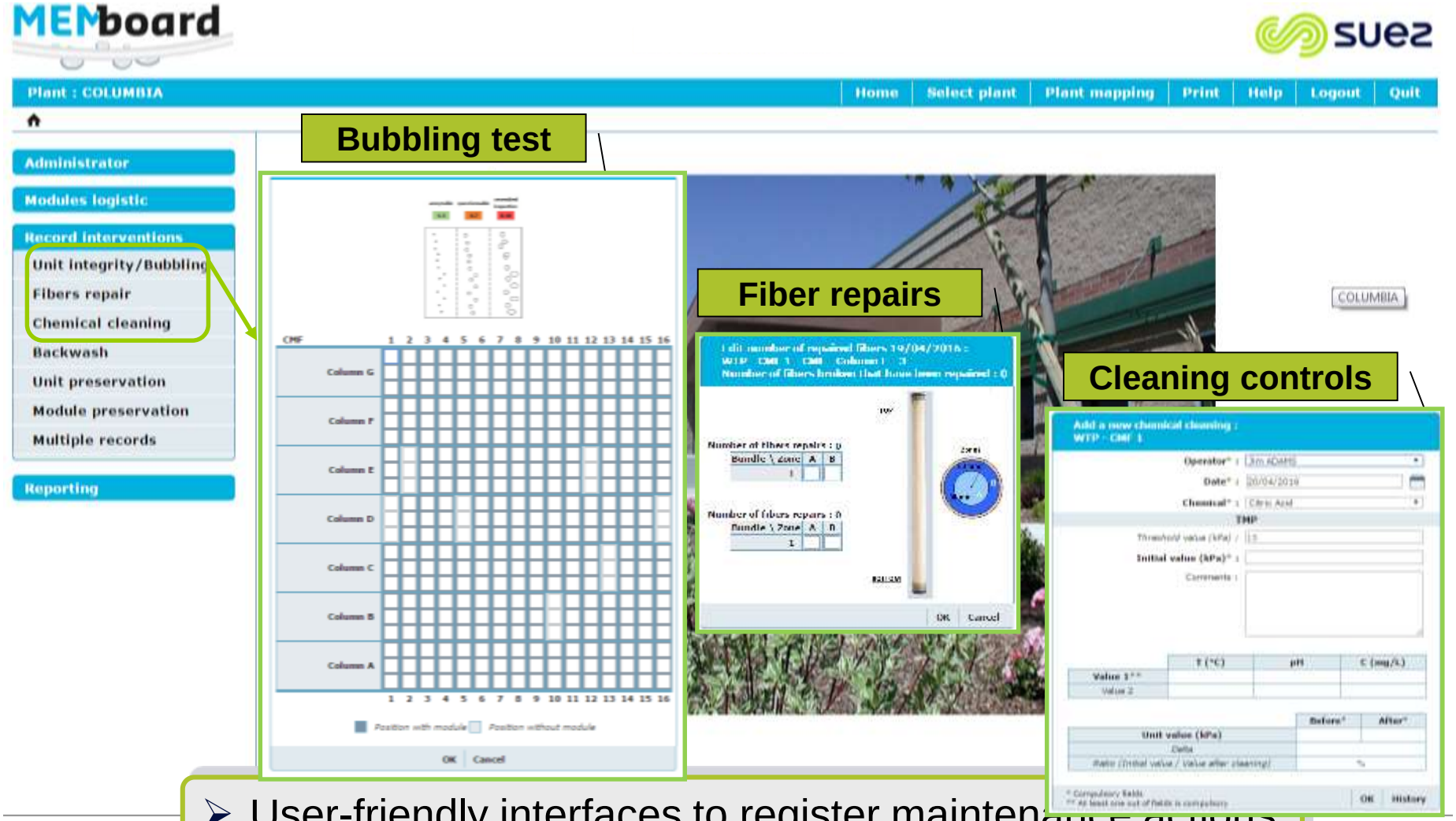
Screen shots
Modules logistic



- Easy handling of the modules: shift, store, put back in line, insert new modules, etc.

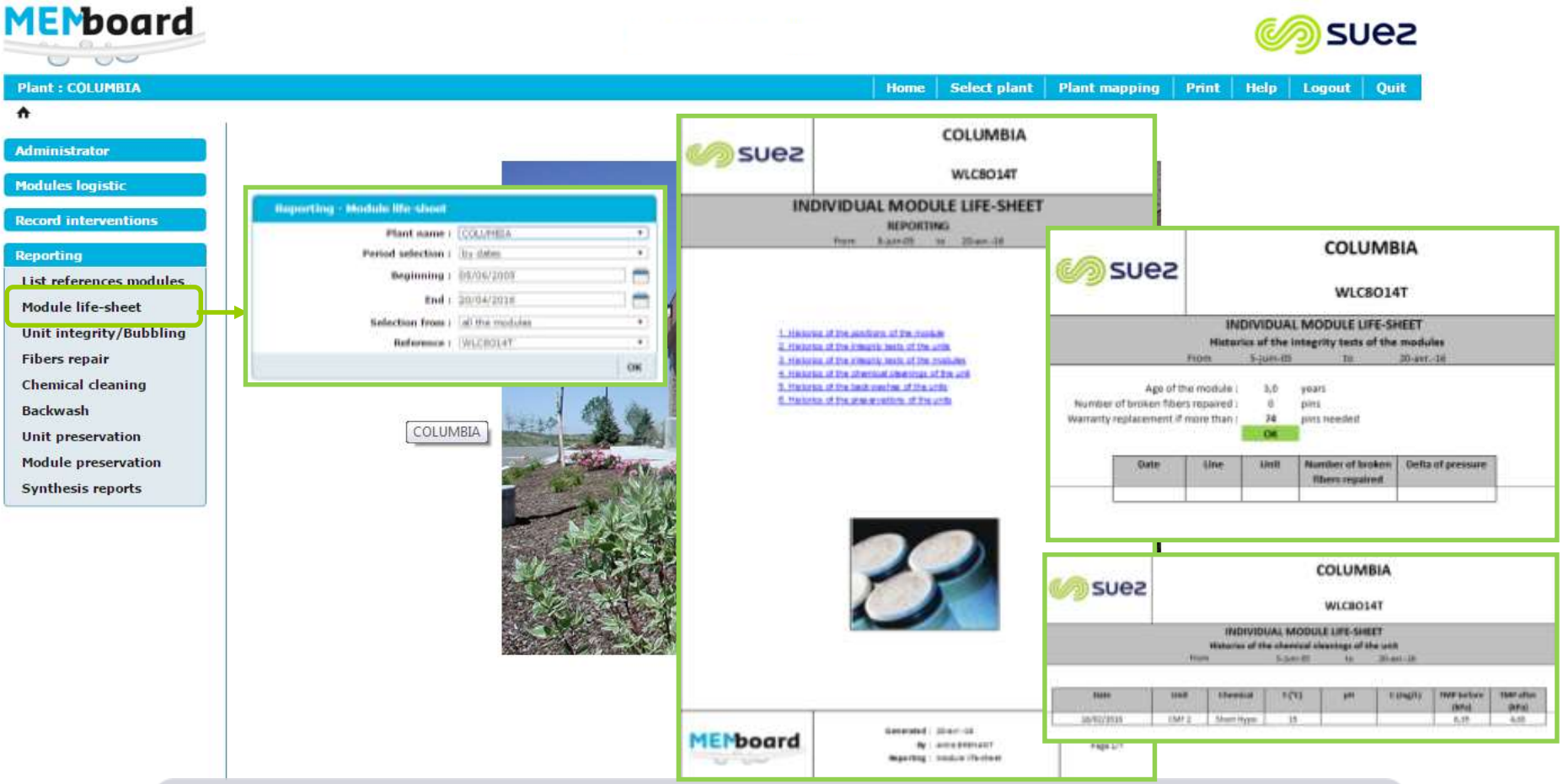
suez

Screen shots
Record forms



➢ User-friendly interfaces to register maintenance actions

Screen shots
Module life-sheets



➢ Individual life-sheets per module compiling entire history of registered interventions (module + rack) ▶ **Excel files**

Screen shots
Reports & dashboards

- Fully automated and graphical balance sheets generated on demand in any selected time frame (for ex, since commissioning) ▶ **Excel files**