NANO STRUCTURED BIO AND ARSENIC SORBENTS

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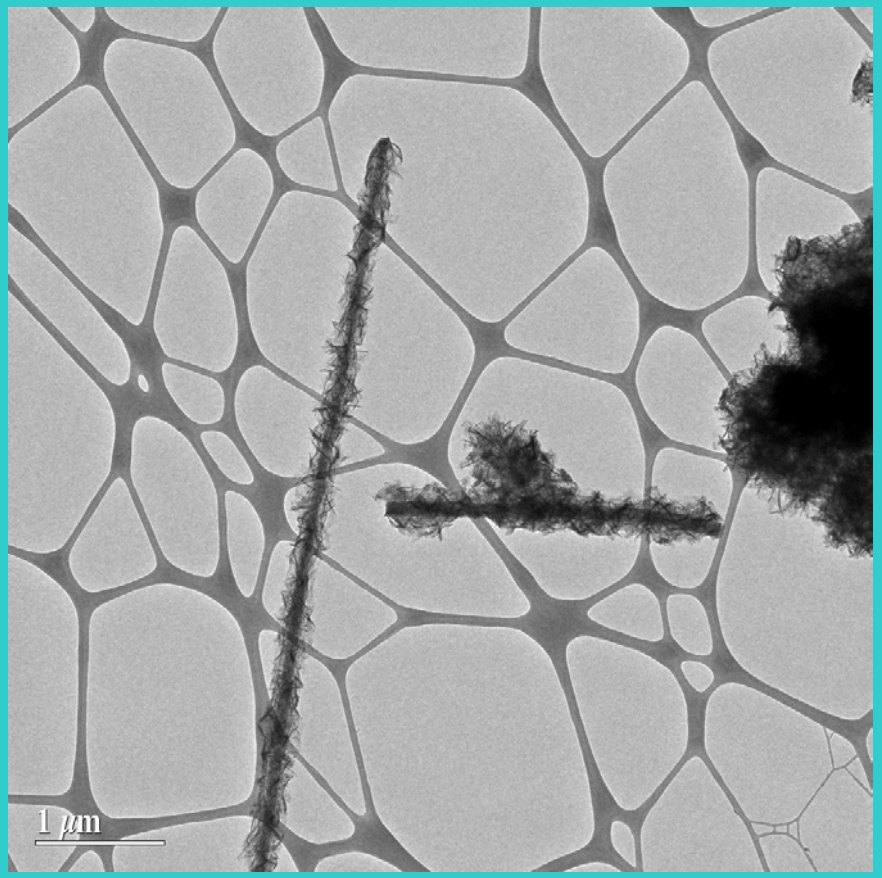
BACKGROUND

- We produce nanopowders including a nano alumina fiber 2 nanometers in diameter (NanoCeram^{R})
- Filters developed from NanoCeram- received "Best New Product" award in 2002
- The filters are electropositive and will retain turbidity and most sub-micron particles
- Retains virus, bacteria and cysts to >99.9999% and <u>at fluxes hundred of times</u> greater than an UP membrane
- Far more resistant to clogging than membranes
- The filters are being sold for lab and biotech applications
- What about coagulation/filtration processes?

ACTIVE PROGRAMS

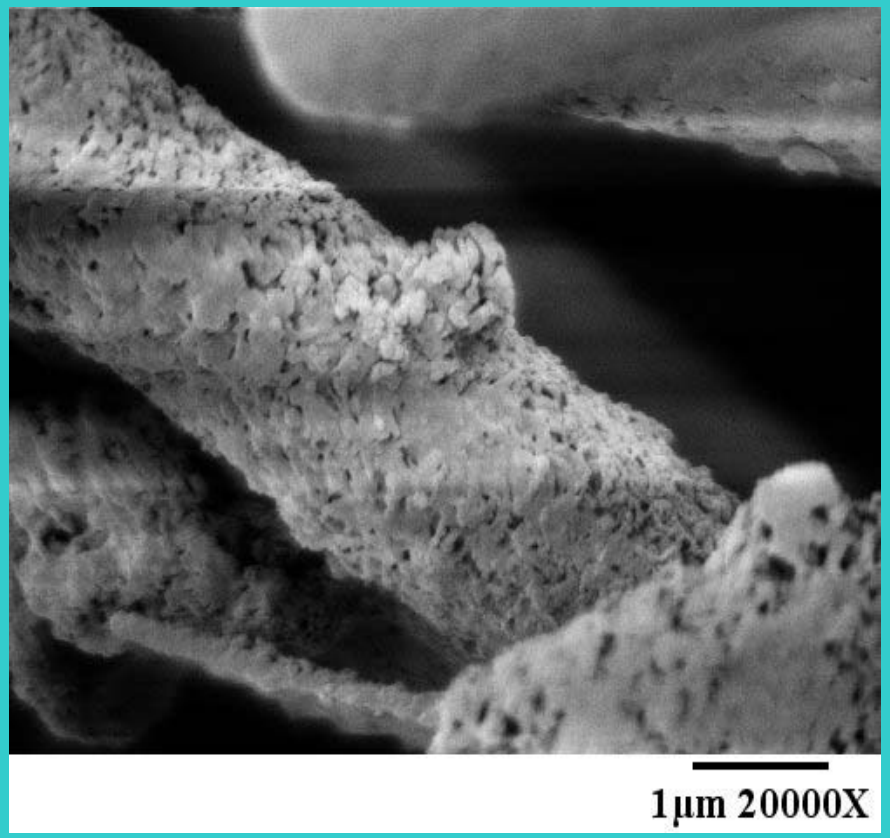
- DOE CRADA – (4th year)- In collaboration with NREL, support several Russian institutes on nanotechnology
- NASA SBIR (Phase II) – Developed a filter for removing pathogens from recycled space cabin water
- DTRA - NanoCeram retains BW agents – This study is to demonstrate enrichment of BW for detectors
- NIH Subcontract- Demonstrate feasibility of collecting virus-containing aerosols - >99.999% MS-2 collected.
- In house- POU cartridge "Bio" filter and a portable purifier for campers, backpackers and military

NANOCERAM ON MICROGLASS FIBERS



Active Nano alumina on glass fiber adsorbs virus

MONODISPERSE LATEX SPHERES (30 nm) DEPOSITED ON NANOCERAM COMPOSITE FIBERS



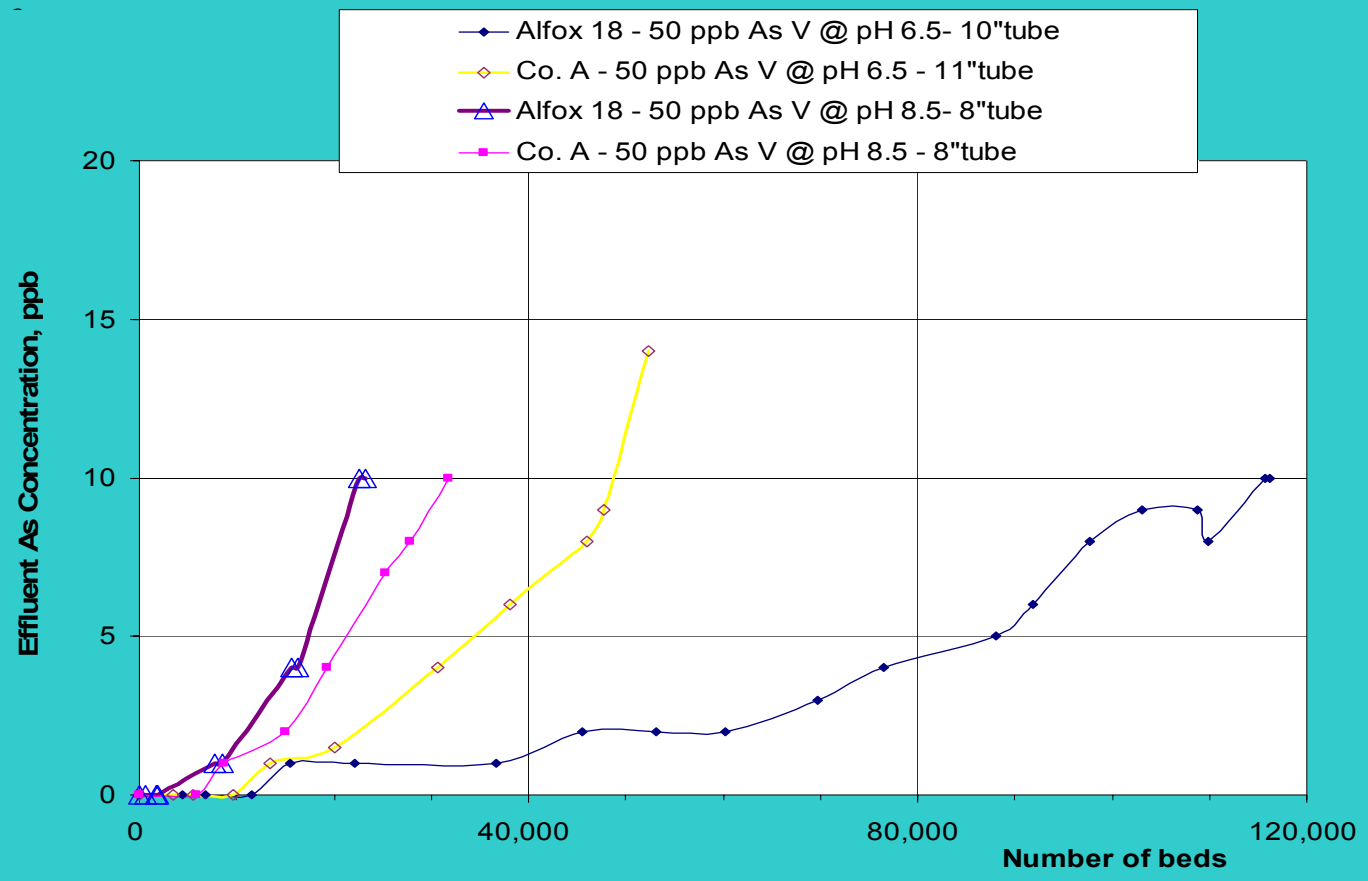
EPA ARSENIC PROGRAM APPROACH

Primary Goal- Improved Sorbent for reducing As III and V from 300, 50 to <10 ppb @ pH 6.5 and 8.5 in a POU format

Steps

- Optimize equilibrium As capacity
- Determine dynamic capacity in short beds
- Determine dynamic capacity in deep beds
- Develop a useful model
- Benchmark vs. other arsenic sorbents

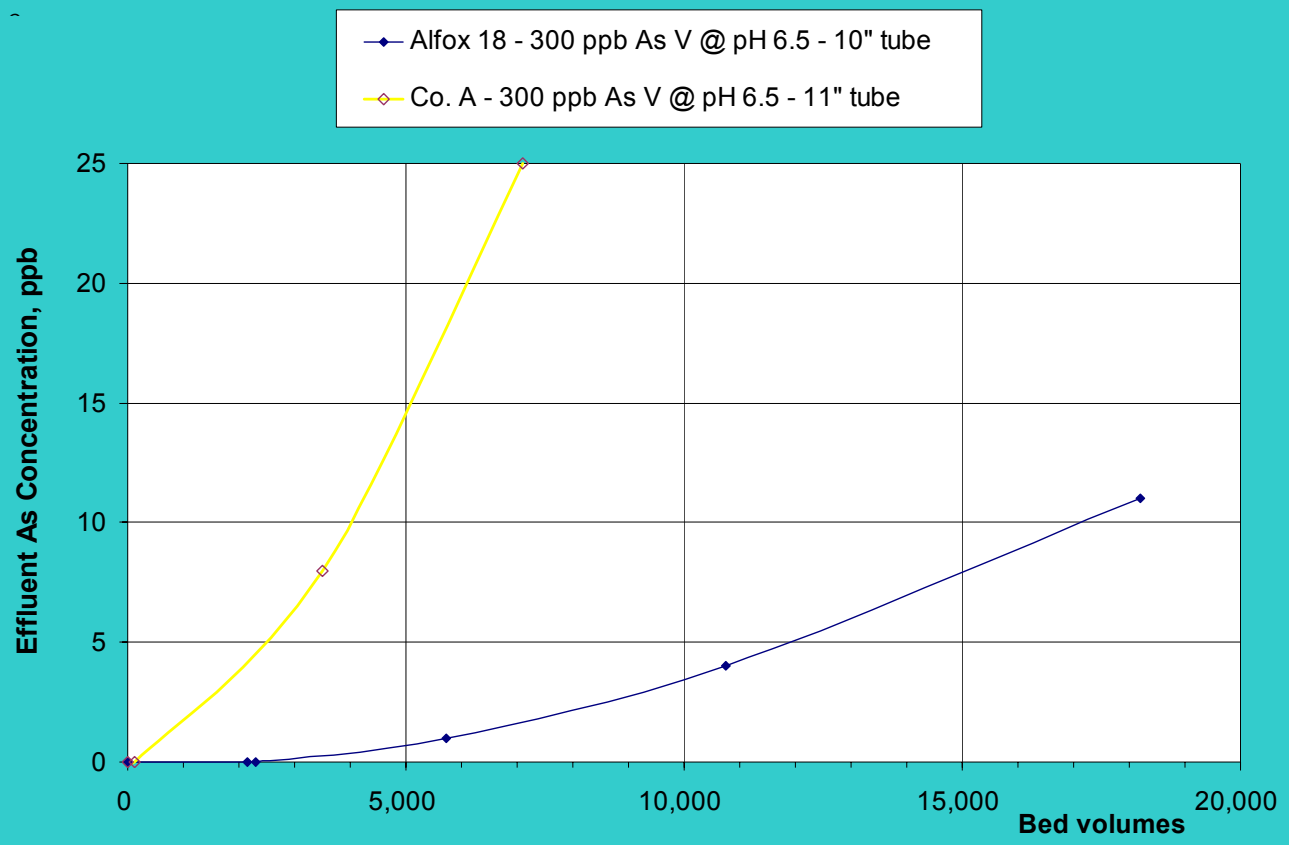
Dynamic Adsorption of 50 ppb As V @ pH6.5 and 8.5



Alfox capacity is several times greater under neutral or acidic conditions

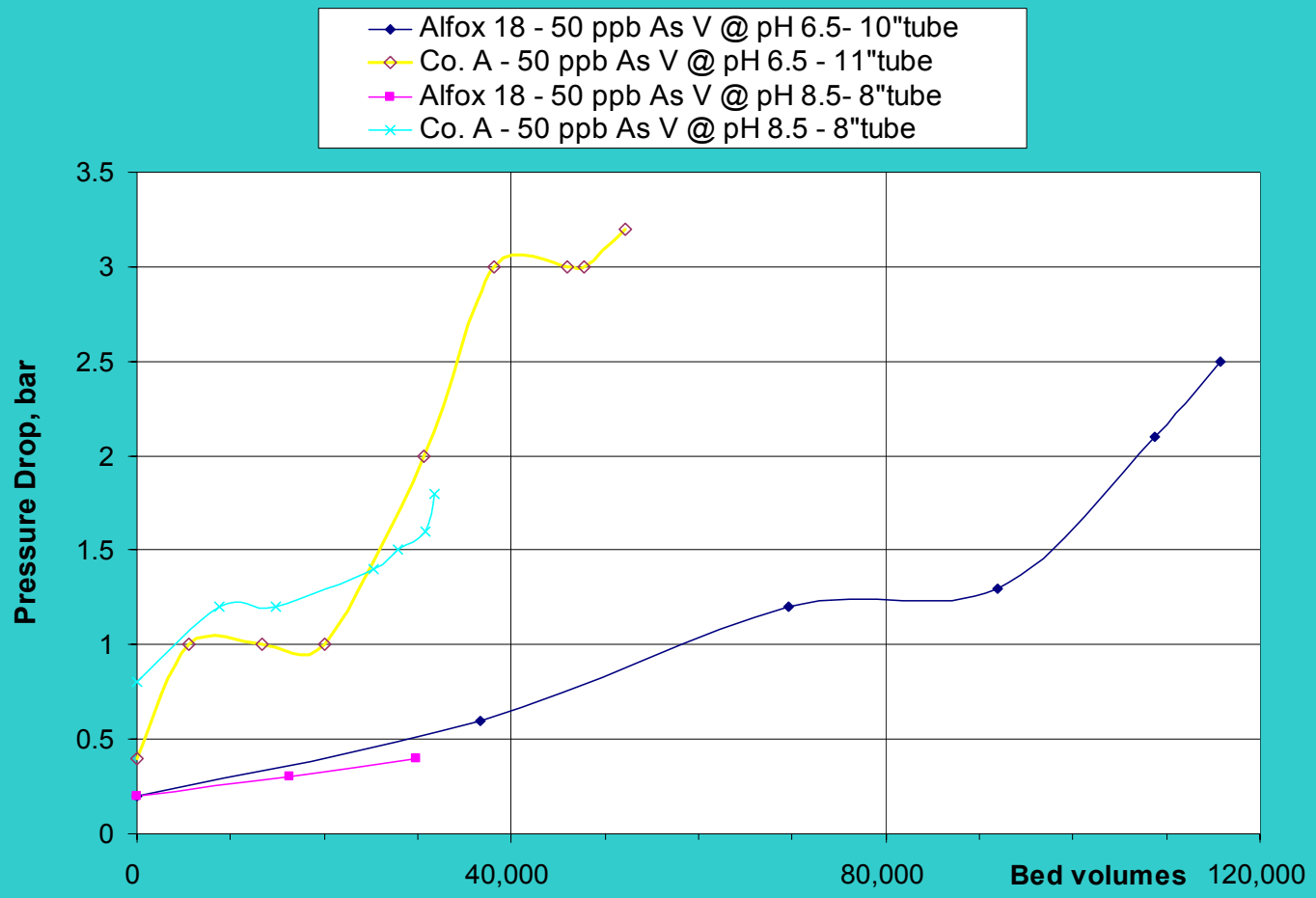
Dynamic Adsorption of 300 ppb As V

Alfox 18 vs Company A (pH 6.5-10" tube)



Alfox has far greater capacity at 300 ppb Arsenic (V)

FLOW IMPEDANCE BUILD UP- Co. A and Alfox 18

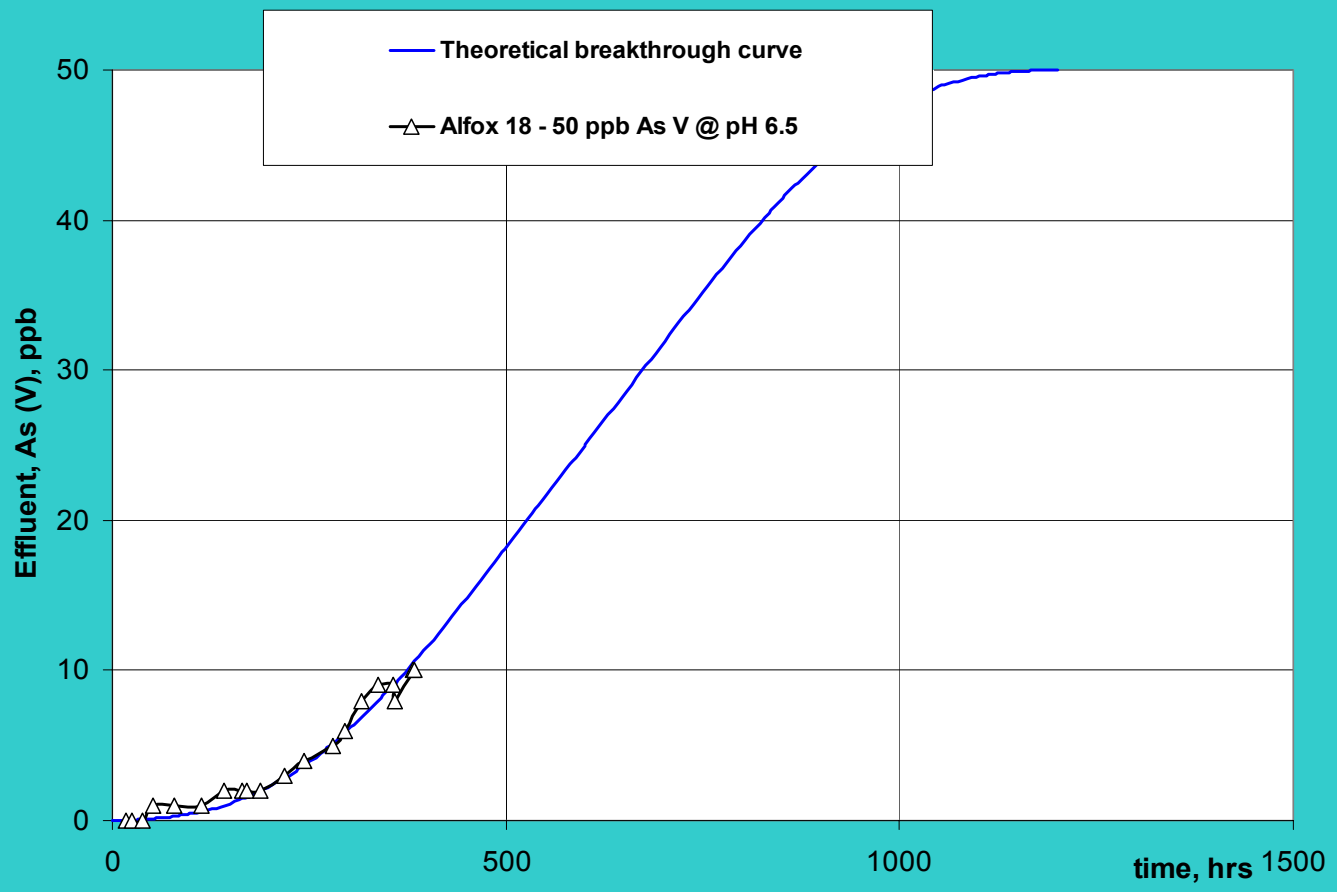


Question: Can erosion cause a peaking problem?
Conclusion: Alfox is more erosion resistant but we need to do better and we know how

MODELING THE ADSORPTION PROCESS

- PURPOSE
  - SCALE FROM SHORT BEDS TO FULL SIZE POU
  - PROJECT BREAKTHROUGH AS FUNCTION OF C
- DEMONSTRATED VERY GOOD FIT OF EXPERIMENTAL DATA WITH LANGMUIR AND FREUNDLICH ISOTHERMS
- GATHERED DATA ON SHORT VS LONGER BEDS
- DEVELOPED A DYNAMIC MODEL BASED ON CONSTANTS RELATED TO THE SHAPE OF THE BREAKTHROUGH CURVE
- MODEL SUITABLE FOR As III & V AND ALSO FOR COMPANY A SORBENT

COMPARISON WITH MODEL



The model describes the breakthrough curve as a function of concentration, flow, pH and bed depth.

PROJECTED CAPACITY FOR POU
(2.75" Diameter X 10" long bed)

Valence	Concentration (ppb)	pH	Capacity to 10 ppb, gallons
As (V)	50	6.5	20,500
		8.5	7,300
	300	6.5	1,300
		8.5	300
As (III)	50	6.5	8,300
		8.5	9,800
	300	6.5	600
		8.5	500

Static Adsorption of 300 ppb Cr(VI)

Sorbent	pH 6.5	
	Cr(VI), ppb in filtrate	mg Cr(VI) sorbed/g sorbent
18	21	5.6
	189	6.9
26	86	2.1

FEATURES AND BENEFITS

- SUPERIOR DYNAMIC ADSORPTION, PARTICULARLY UNDER NEUTRAL OR ACID
- BETTER EROSION RESISTANCE
- PREDICTABLE ADSORPTION PERFORMANCE
- ADSORBS SUBSTANTIAL # OF VIRUS

FUTURE TASKS

- Testing with phosphate, silica
- Improve pH 8.5 performance
- Further enhance erosion resistance
- Pilot manufacture sorbent
- Construct full size cartridge and alpha test
- ETV test

OUR DESIGN DILEMMA FOR A 2.75" x 10" CARTRIDGE

WILL EPA REQUIRE THE POU (2.75 x10") CARTRIDGE TO BE TESTED SEMI-ANNUALLY?

IF SO, DOES IT MAKE SENSE TO WARRANT ONLY 6 MONTHS AND HAVE THE CARTRIDGE ONLY ABOUT 1/3 FULL? WE COULD USE THE ROOM FOR A BIO FILTER

OR SHOULD WE DESIGN FOR 1 OR MORE YEAR CERTIFIED USE? WE WOULD NEED TO DO MORE STUDIES ON BIO PROLIFERATION AND DEVELOP BIOCIDAL SYSTEMS