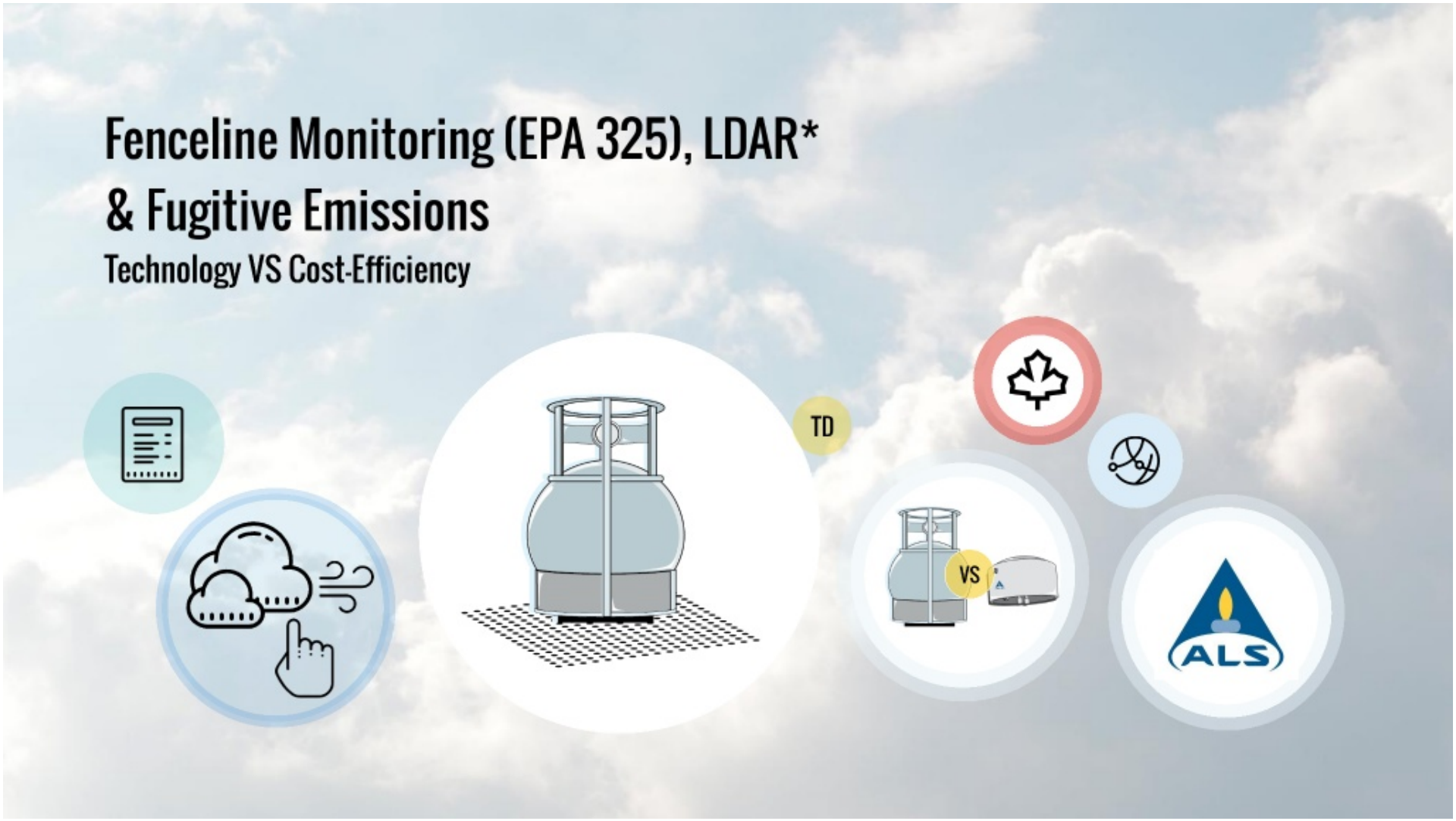

Fenceline Monitoring (EPA 325), LDAR*
& Fugitive Emissions
Technology VS Cost-Efficiency
TD
VS
ALS

Leak Detection & Air Monitoring

Progression

Direct Reading Instruments
Tubes and pump (colourimetric), PID gas detector, weather station/air monitor

Canister Sampling

Tube Sampling
Active with Soil Vapour Intrusion TD tubes (SVI)

Passive Fenceline Monitoring
Passive TD tubes - Carbopak X media

Update
Regulations Respecting Reduction in the Release of Volatile Organic Compounds

Public Access To Data
Sarnia, ON facilities

Direct Reading Instruments

Cost & Reliability

Cost (est. CAD)

Tubes (Colorimetric) **& Pump**

- Quick and easy, instant results
- Colourimetry can be prone to positive and negative interference
- Requires knowledge of leak or plume location

$600 + $100

Handheld PID (Photo-Ionization Detector)

- PID provides a great starting point in determining if there is a problem
- Potential for interferences
- Requires knowledge of where the leak or the plume may be

$800 - $7500

Rent/Week ~$350

Weather Station + GC Instrumentation

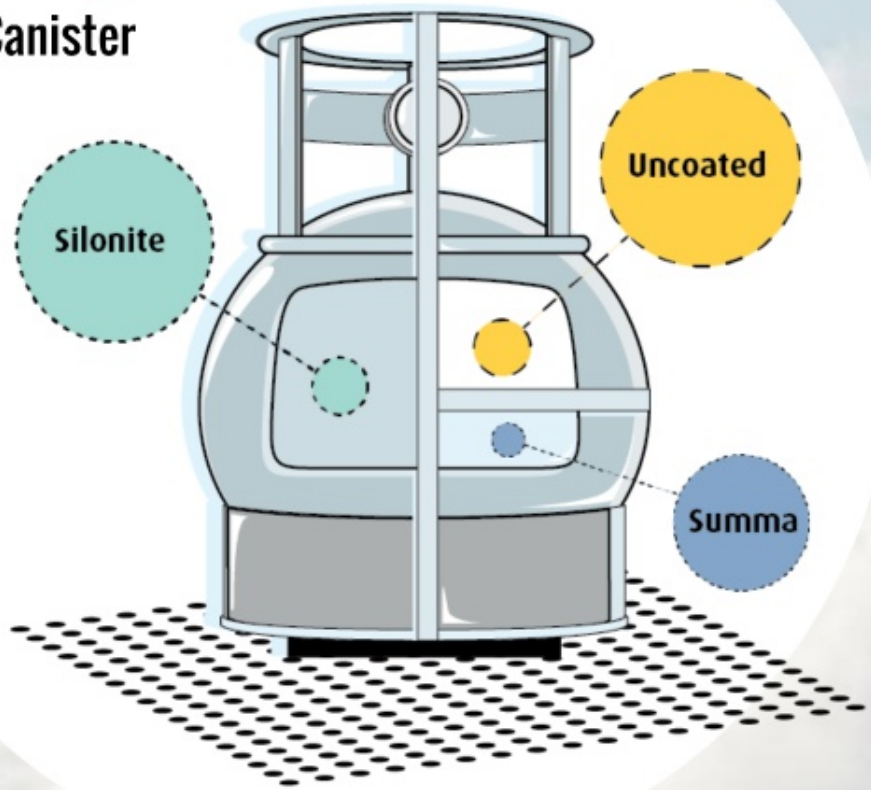
- Accurate, but only situated in one location, plume must cross its sampling area to accurately measure VOCs
- Must be maintained and calibrated by qualified staff

$30k+

Cost Prohibitive

Installing & locating multiples

Silonite Canister VS Summa & Uncoated Canister



Coatings

Whole Air Sampling

Uncoated

- Rapidly lose their ability to recover important VOCs such as carbon Tetrachloride.
- During the manufacturing of 6L half shells, organic contaminants in the form of grease and oils become trapped in the surface pores found in stainless steel metal.
- Interior will easily corrode.

Silonite

Summa

Silonite™

- 100% inertness tested prior to shipment. Polished internal surface prior to Silonite™ coating the most inert surface possible.
- All Entech Canisters are coated in Silonite™ to ensure there is no chance of corrosion and the subsequent loss of reactive compounds.
- Silonite™ canisters are the only 'inertness-repairable' canisters on the market. No need to fear canister inertness testing, Entech's renewal process can retun old Silonite™ can to often better than new conditions.
- Externally electro-polished "after" Silonite™ coating to provide a more analytical and professional look.

SUMMA

- The metal oxides found in SUMMA canisters can actually be a catalytic in promoting certain chemical reachtions.
- Because of the limited inertness of the SUMMA canister, a certain amount of water vapor is actually needed to allow Air Toxic compounds to remain stable. Even aromatic hydrocarbons can be lost to the surface of a SUMMA canister if enough water isn't present.

Silonite Coated Canisters

1L, 1.4L and 6L can be utilized for air sampling:

- soil gas/soil vapour
- ambient air
- indoor air - easy to use

Cost (est. CAD)

4 - 24hr Canisters, q2wk, TO15

~$33k

(equip-analysis-40wk)

It is critical when requesting air sampling equipment to provide sufficient information regarding the sampling event(s):

- What type of air is being sampled?
- What is the length of time being sampled?
- What criteria need to be met?

Thermal Desorption (TD) Tubes

Media/Resin Adsorption

Active Sampling

- SVI tubes are used in active sampling (soil vapour intrusion or ambient air) to analyze for VOC's (TO-17)
- TD tubes contain 3 types of media
  - weak,
  - medium
  - strong adsorbent
- Tubes can be reused; the process of desorbing "strips" the tube of all collected VOC's and an additional thermal cleaning process, followed by proofing (analysis of cleaned tubes)

Cost (est. CAD)

5-TD Tubes, q2wk, TO-17

~$40k

(equip+pumps+analysis-40wk)

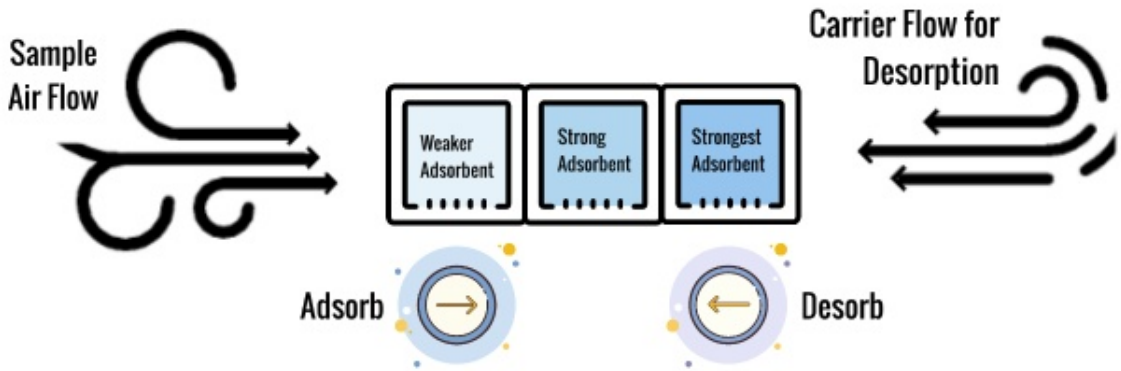
Thermal Desorption Tube Sampling (USEPA TO-17)

For active sampling

- Multi-adsorbent TD tube (PerkinElmer SVI) that offers wide VOC molecular range
- Large safe sampling volumes (SSV)
- Good water management
- Low media background

For passive sampling

- A specific single-adsorbent TD tube & cap



Thermal Desorption (TD) Tubes

Continuous Monitoring

Active Sampling

- Passive sampling using single media Carbopak X TD tubes
- EPA 325 method allows for continuous sample collection
  - up to 25 VOC compounds and is a cost effective technique that aids in LDAR (leak detection and repair) at petrochemical facilities.
- TD tubes are also used for other types of testing including 4-PCH
  - a compound used for evaluation of LEED certification, and Siloxanes

Cost (est. CAD)

10-TD Tubes, q2wk, 25 VOCs

~$45k

(equip+pumps+analysis-40wk)

Sampling - EPA 325 Tube Carbopack X

- Carbopack X is a hydrophobic granular graphitized carbon black (GCB) adsorbent with a large surface area of 240 m2/g that allows it to retain a broad range of VOCs
- Inner surface of SS tubes are inert coated to protect sample integrity over the relatively long sampling period
- Sorbents medium range is optimal for BTEX (C6-C8) & 1,3-butadiene (C4) sampling, as well as various other VOCs

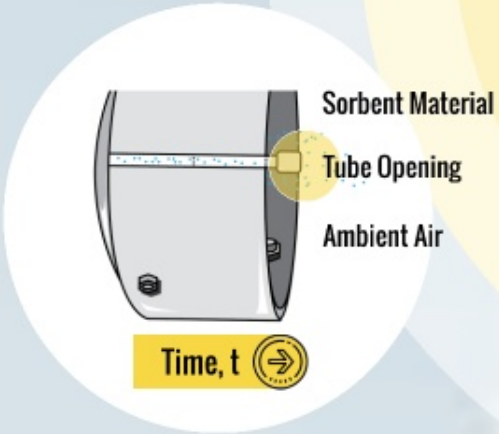
How Does it Work?

Uptake Rates

Passive Sampling - Maximizing Efficiency

How does passive sampling work?

- Sorbent inside the tube is exposed at one end for a known amount of time, in which diffusion dictates concentration equilibrium.
- Any extreme changes in wind vector (convective forces) are mitigated by the use of diffusion caps.
- Values are calculated by relating the compound quantity adsorbed on the sorbent to the relative rate of diffusion (uptake rate) of the compound.



Sorbent Material
Tube Opening
Ambient Air

Sampling - Carbopack X VOC Uptake Rates

Compound	Carbopack X uptake rate (ml/min)[a]
1,3-Butadiene	0.61±0.11
1,1-Dichloroethene	0.57±0.14
3-Chloropropene	0.51±0.3
1,1-Dichloroethane	0.57±0.1
1,2-Dichloroethane	0.57±0.08
1,1,1-Trichloroethane	0.51±0.1
Benzene	0.66±0.06
Carbon tetrachloride	0.51±0.06
1,2-Dichloropropane	0.52±0.1
Trichloroethene	0.5±0.05
1,1,2-Trichloroethane	0.49±0.13
Toluene	0.52±0.14
Tetrachloroethene	0.48±0.05
Chlorobenzene	0.51±0.06
Ethylbenzene	0.46±0.07
m,p-Xylene	0.46±0.09
Styrene	0.5±0.14
o-Xylene	0.46±0.12
p-Dichlorobenzene	0.45±0.05

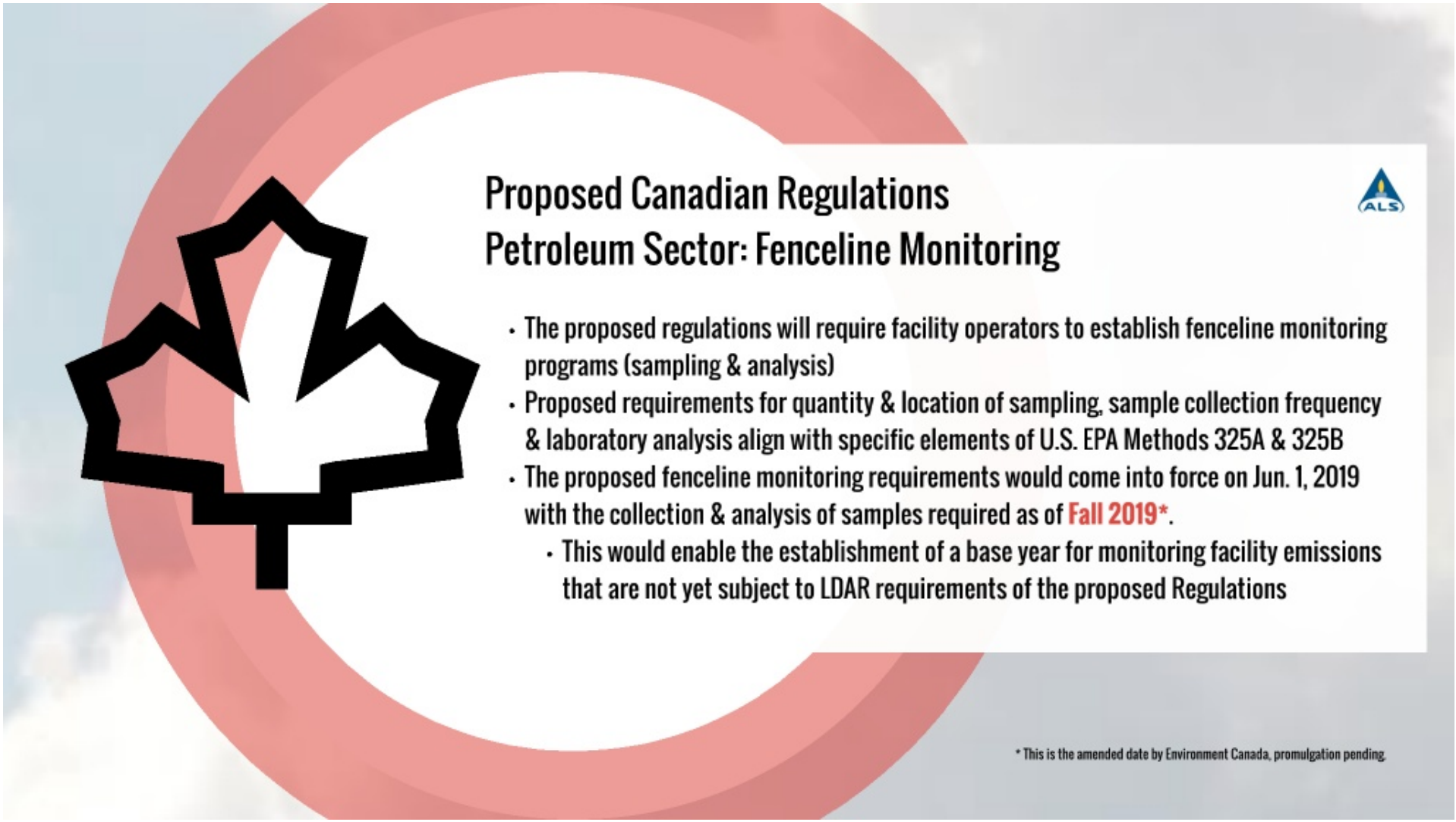
(a) McClenny, W.A., et. al., J. Environ. Monit. 7:248-256.

Silonite Canisters

- Quantitative recovery of low MW VOCs (C1-C3 range)
- Prior knowledge of VOCs air concentration is not a controlling factor in sampling (no saturation or safe sampling volume issues)
- Silica coated canisters provide best stability of VOCs, including sulphur & other reactive compounds. No pump needed, canisters under vacuum
- Multiple (sample dilutions) & different (instruments) analyses are possible from the same canister

Thermal Desorption (TD) Tubes

- Good recovery of higher MW, and polar VOCs (e.g. siloxanes, low MW PAHs, etc.)
- Prior knowledge of VOCs air concentration is important, safe sampling volumes (SSV) need to be adhered to, Vinyl Chloride is limiting factor (10L) (active sampling)
- Passive sampling - extended sampling times without a pump. Sampling applications include: fenceline(EPA 325), buildings(walls, ducts), confined space, pipeline, well, etc.
- Volume of air collected can be adjusted to meet low regulatory limits, single complete tube desorption. Small size - personal & area sampling; easy to ship


Proposed Canadian Regulations
Petroleum Sector: Fenceline Monitoring
• The proposed regulations will require facility operators to establish fenceline monitoring programs (sampling & analysis)
• Proposed requirements for quantity & location of sampling, sample collection frequency & laboratory analysis align with specific elements of U.S. EPA Methods 325A & 325B
• The proposed fenceline monitoring requirements would come into force on Jun. 1, 2019 with the collection & analysis of samples required as of Fall 2019*.
• This would enable the establishment of a base year for monitoring facility emissions that are not yet subject to LDAR requirements of the proposed Regulations
* This is the amended date by Environment Canada, promulgation pending.

Proposed Canadian Regulations
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- Proposed requirements for quantity & location of sampling, sample collection frequency & laboratory analysis align with specific elements of U.S. EPA Methods 325A & 325B
- The proposed fenceline monitoring requirements would have come into force on **Jan. 1, 2018** with the collection & analysis of samples-promulgation pending -
- update anticipated: **Jun 1, 2019***
  - This would enable the establishment of a base year for monitoring facility emissions that are not yet subject to LDAR requirements of the proposed Regulations

*Amended to the later date by Environment Canada, and confirmed that this is the most recent update as of Mar 15, 2019.

Publicly Posted Benzene Data From Fenceline Program

> Summary of some of the historical data from 2016-2018 for benzene from facilities monitoring in the Chemical Valley (Sarnia, ON).

- https://www.suncor.com/about-us/refining/sarnia-refinery
- https://www.shell.ca/en_ca/about-us/projects-and-sites/sarnia-manufacturing-centre.html
  https://iolfencelinemonitoring.ca/en/Sarnia
- https://www.ineos-styrolution.com/portal/zh_CN/environment