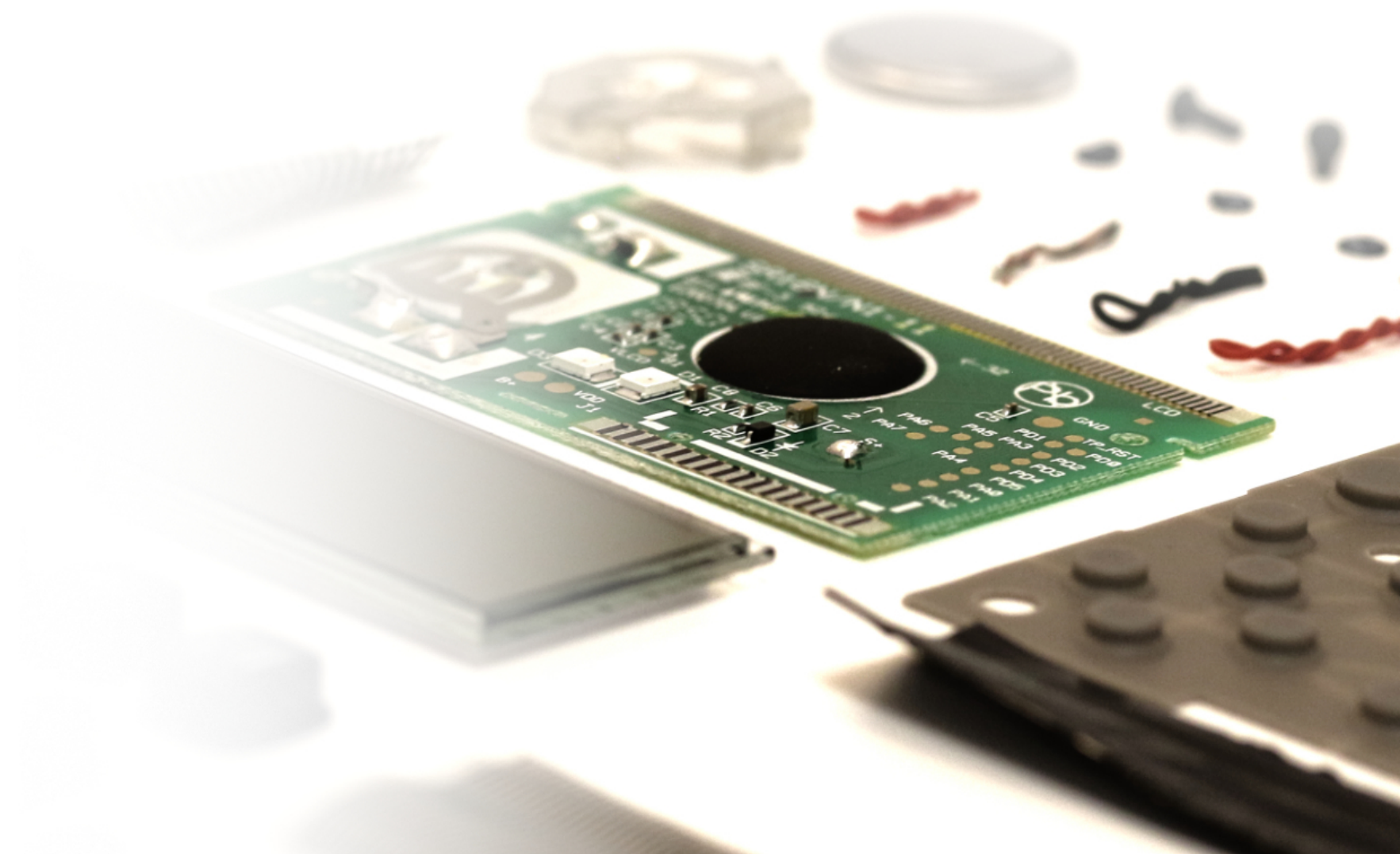


PFAS in Articles (Updated)

Claigan Environmental

Presented by:
Bruce Calder
VP of Operations

August 30, 2023



Overview - Agenda

- PFAS legislation
- Testing process
 - Fluorine concentration (WDXRF)
 - Fluorosalts (LC-MS/MS)
- PFAS testing results
 - Pie chart of results
 - Breakdown of each commonly measured PFAS component
 - Use
 - PFOA risk
- Q&A



**Webinar
60 minutes
with 10 minutes Q&A**

Claigan EU PFAS Restriction Project

- **Project**
 - Claigan is working with dozens of companies to submit
 - 4 technical submissions on PFAS
 - 1 submission on PFAS derogations needed
- Companies can still join
 - Submission date to EU is September 25 2023
- **Easily the most informative and most useful project on PFAS**

Claigan EU PFAS Consultation Submission Project



Submissions

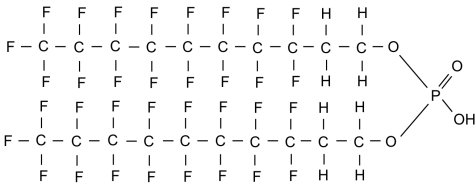
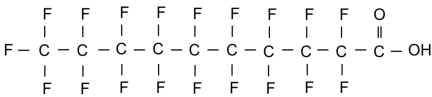
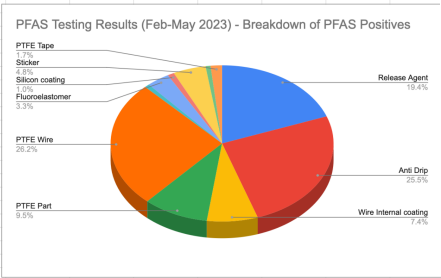
PFAS in Articles

Sources of PFOA

PFOA in the Environment

Comparison of Alternatives

Derogations Needed



Comparison	PTFE	PEEK	Silicone	Polyurethane	PFA	Irradiated PTFE	gPTFE	Fluoroacrylate
Low Friction	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature resistant	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Forever Chemicals	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Poor
Biocompatibility	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent

PFAS	Co-Axial Connector
Intentionally added	Yes
Chemical	PTFE
Cas number	9002-84-0
Concentration in component	50%
Purpose of PFAS	PTFE is a polymer with chemical, thermal, mechanical and electrical properties that are capable of satisfying the most demanding requirements in the industry. It is anti-adherent, low friction, resistant to almost all chemical products, inflammable and has excellent dielectric properties. Dielectric constant - The speed of a signal traveling through a coaxial cable depends on the dielectric constant of the insulating material between the center conductor and the outer conductor. Thus, cable assemblies use polytetrafluoro-ethylene (PTFE) to minimize signal delay. PTFE bearings - PTFE has very low friction; excellent strength, stability, and wear characteristics; good heat conduction, and low thermal expansion.

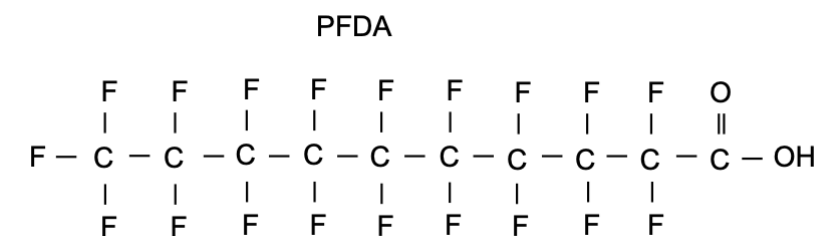
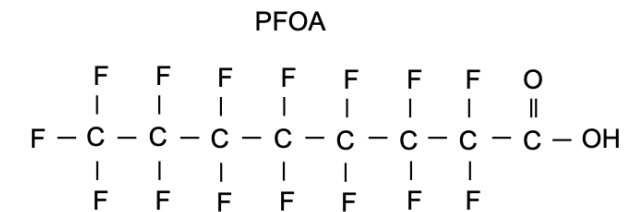
Claigan EU PFAS Restriction Project

Tentative Schedule

#	Milestone	Date	Complete
1.0	Customer Uses	Provided upon sign-up	Yes
2.0	Introduction Meeting	July 12 & 13 2023	Yes
3.0	Customer Uses Deadline	July 14 2023	Yes
4.0	Draft Derogations Meeting	August 2, 2023	Yes
5.0	Draft Technical Submissions and Update on Derogations	September 6 2023	
6.0	Final Derogations Submission Meeting	Mid September 2023	
7.0	EU PFAS Submission Deadline	September 25, 2023	

- **REACH Regulation (longer versions of PFOA**

- **POP Regulation (PFOA)**
 - PFOA banned at 25 ppb
 - And substances that degrade into PFOA (260 ppb)
 - Jul 4 2025 for invasive or implantable devices
- **REACH Regulation (longer versions of PFOA)**
 - Feb 25 2023 - LCPFAC (longer versions of PFOA) banned at 25 ppb
 - Jul 4 2025 for invasive or implantable devices
 - Cannot have PFOA or longer in a component above regulated limit



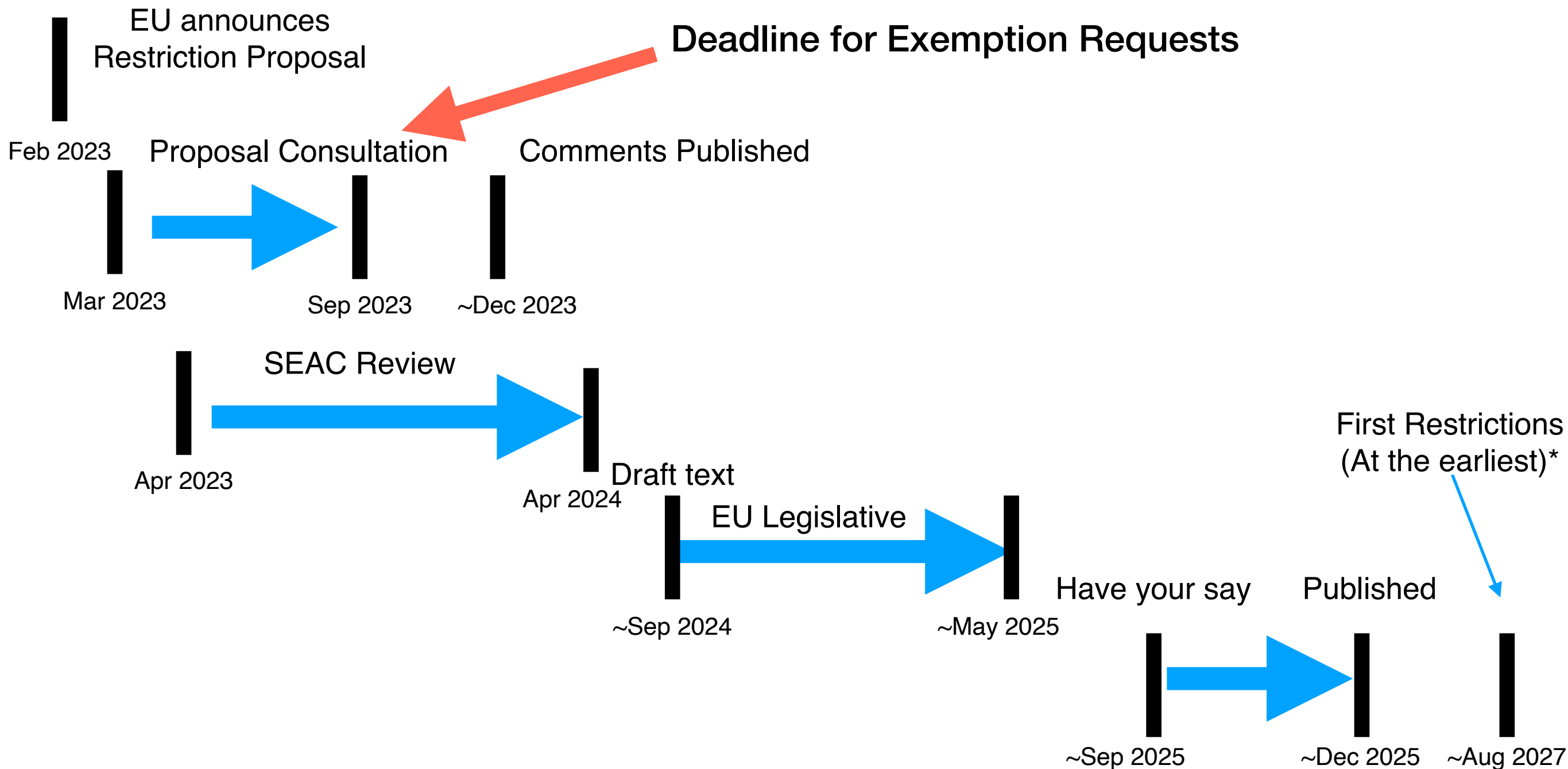
Model Legislation

US State - PFAS

- US state legislation based on model [legislation](#)
 - In absence of federal legislation
 - *Maine, Minnesota, California, etc..*
- Details
 - Template of model legislation for each participating state to use
 - Details may vary once they complete the legislative process in each state
 - But restriction and reporting requirements intended to be the same
- In the medium term, PFAS reporting will likely be through a common platform such as the [Interstate Chemical Clearinghouse](#)

Timeline for EU PFAS Ban

- EU proposes a broad ban on PFAS in products



Claigan PFAS Testing

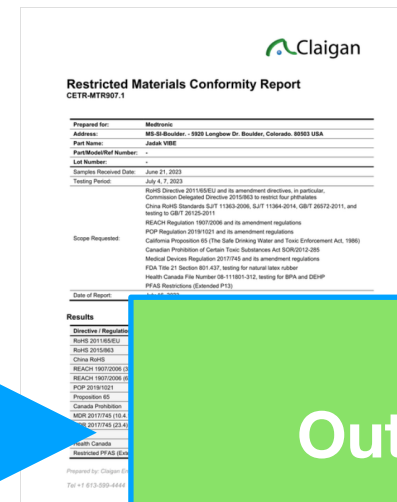


Screening
WD-XRF +
FTIR

If PFAS present

LC-MS/MS
PFOA and similar

Output



REPORTABLE PFAS

- detect F over 50 ppm
- /w FTIR also identifies
 - CAS #
 - Use

RESTRICTED PFAS

- detect PFOA family to 25 ppb

Test report + Reportables

PFAS	PFOE Wts	Fluorotelomer	Fluorotelomer
Intentionally added	Yes	Yes	Yes
Chemical	PFOE	Vinylidene fluoride-hexafluoropropylene polymer	Vinylidene fluoride-hexafluoropropylene polymer
Chemical	600-84-0	9011-17-0	9011-17-0
Concentration in component	50%	100%	100%
Purpose of PFAS	PFOE is commonly used in various applications, including as a component in various polymers, coatings, and lubricants. It is also used in various industrial processes, such as the production of various chemicals and materials.	Vinylidene fluoride-hexafluoropropylene polymer (commonly called Viton) is the most durable and high performing rubber on the market. It is a generally accepted generic term for a family of fluoropolymers called PFM (or Vinylidene fluoride-hexafluoropropylene polymer).	Vinylidene fluoride-hexafluoropropylene polymer (commonly called Viton) is the most durable and high performing rubber on the market. It is a generally accepted generic term for a family of fluoropolymers called PFM (or Vinylidene fluoride-hexafluoropropylene polymer).
Properties	PFOE is highly resistant to water and oils, making it suitable for use in various applications, including as a component in various polymers, coatings, and lubricants. It is also used in various industrial processes, such as the production of various chemicals and materials.	Viton is highly resistant to water and oils, making it suitable for use in various applications, including as a component in various polymers, coatings, and lubricants. It is also used in various industrial processes, such as the production of various chemicals and materials.	Viton is highly resistant to water and oils, making it suitable for use in various applications, including as a component in various polymers, coatings, and lubricants. It is also used in various industrial processes, such as the production of various chemicals and materials.
Temperature range	PFOE is suitable for use in a wide range of temperatures, from -200°C to +200°C.	Viton is suitable for use in a wide range of temperatures, from -200°C to +200°C.	Viton is suitable for use in a wide range of temperatures, from -200°C to +200°C.
Chemical resistance	PFOE is highly resistant to various chemicals, including acids, bases, and solvents.	Viton is highly resistant to various chemicals, including acids, bases, and solvents.	Viton is highly resistant to various chemicals, including acids, bases, and solvents.
Mechanical properties	PFOE is highly resistant to mechanical stress, including abrasion and tearing.	Viton is highly resistant to mechanical stress, including abrasion and tearing.	Viton is highly resistant to mechanical stress, including abrasion and tearing.
Electrical properties	PFOE is highly resistant to electrical stress, including high voltage and high frequency.	Viton is highly resistant to electrical stress, including high voltage and high frequency.	Viton is highly resistant to electrical stress, including high voltage and high frequency.
Biological properties	PFOE is highly resistant to biological stress, including bacteria and fungi.	Viton is highly resistant to biological stress, including bacteria and fungi.	Viton is highly resistant to biological stress, including bacteria and fungi.
Environmental properties	PFOE is highly resistant to environmental stress, including UV radiation and ozone.	Viton is highly resistant to environmental stress, including UV radiation and ozone.	Viton is highly resistant to environmental stress, including UV radiation and ozone.

Handles

- Maine reporting
- Canada Section 71
- US TSCA reporting
- EU PFAS consultation
- + *Pre-screening for restricted PFAS*

Handles

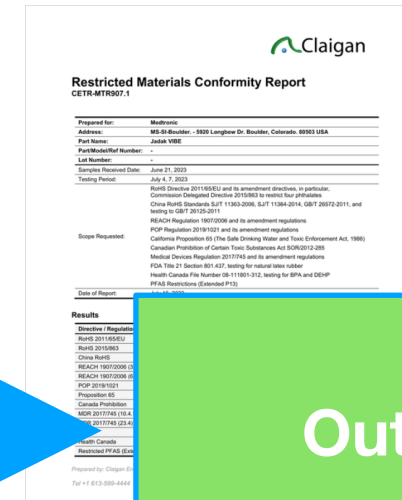
- Prop 65
- EU POP and REACH restrictions
- US TSCA SNUR
- Upcoming Canadian restrictions

Claigan PFAS Polymer Testing



Screening WD-XRF + FTIR

If PFAS present



Output

REPORTABLE PFAS

- detect F over 50 ppm
- /w FTIR also identifies
 - CAS #
 - Use

Handles

- Maine reporting
- Canada Section 71
- US TSCA reporting
- EU PFAS consultation
- + *Pre-screening for restricted PFAS*

RESTRICTED PFAS

- detect PFOA family to 25 ppb

Handles

- Prop 65
- EU POP and REACH restrictions
- US TSCA SNUR
- Upcoming Canadian restrictions

Test report

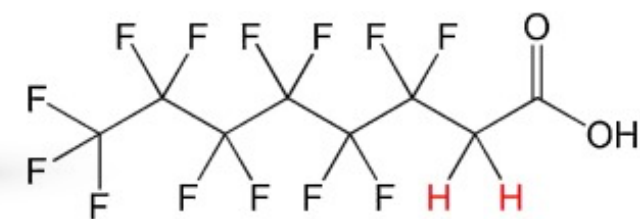
+ Reportables

[illegible]

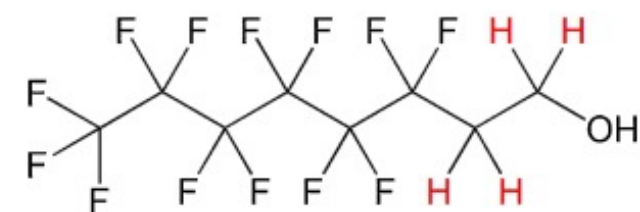
PFAS Simplified

• **Non-Polymer PFAS** 1% of Intentional Uses

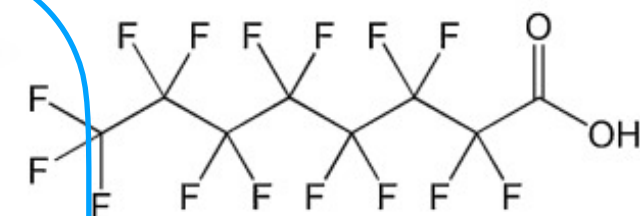
- Non-repeating PFAS (non-polymer)
- Normally **‘water soluble PFAS’**
- **Included in polymers PFAS**



6:2 FTCA



6:2 FTOH



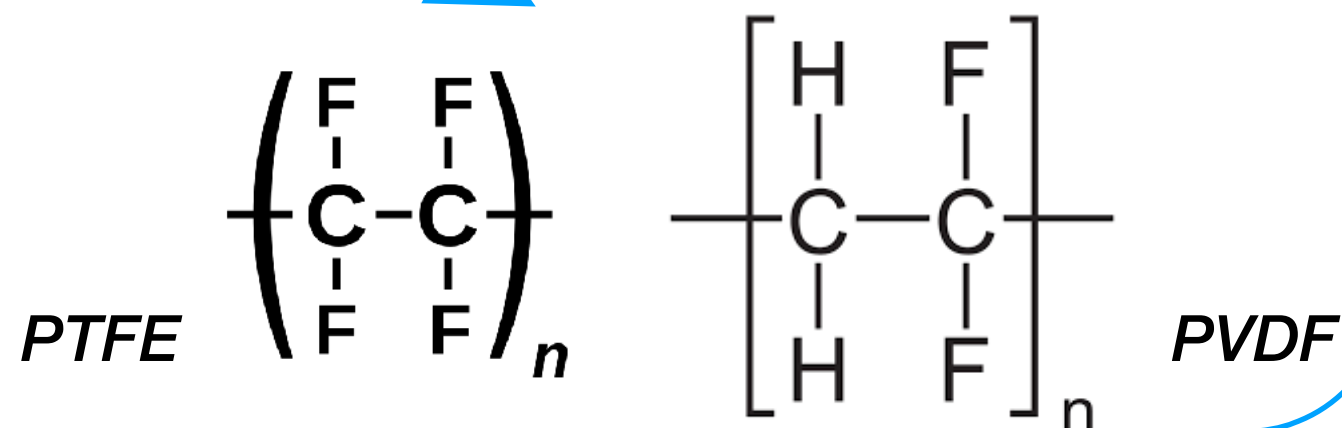
PFOA

WD-XRF

99% of Intentional Uses

• **Polymer PFAS**

- Repeating chains
- Normally the **‘intentionally added PFAS’**



Combustion Ion Chromatography Issues

- Two (2) Fluorine testing methods
 - Combustion - Ion Chromatography (C-IC)
 - Incinerate (combust) the product and test residual fluorine in ash



- Wavelength Dispersive X-Ray Fluorescence (WD-XRF)
 - Directly test the fluorine content of a part



Claigan
Primary Method

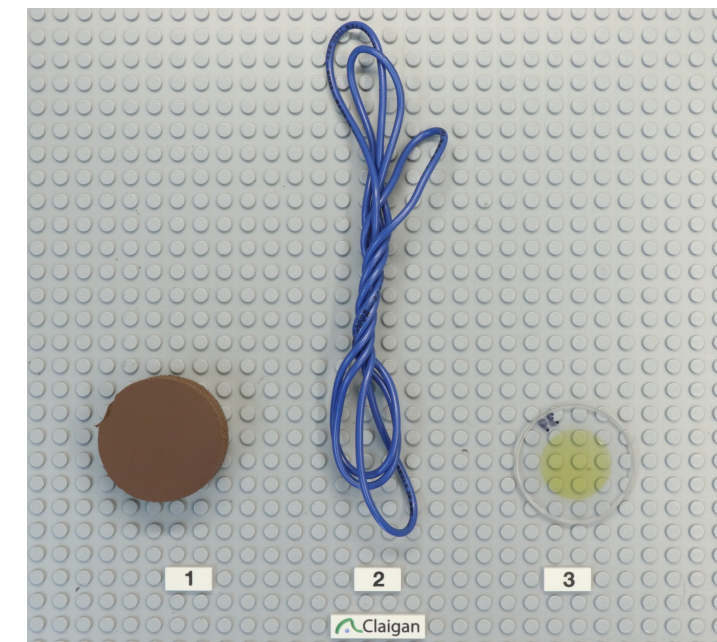
Combustion Ion Chromatography Issues

- Claigan “fluorosprayed” three (3) parts
 - A standard situation for PFAS in products
 - Combustion Ion Chromatography disqualified
- WD-XRF
 - Measured the fluorine in all samples
- CB-IC
 - Only detected fluorine in one (1) sample



Mold Release Spray

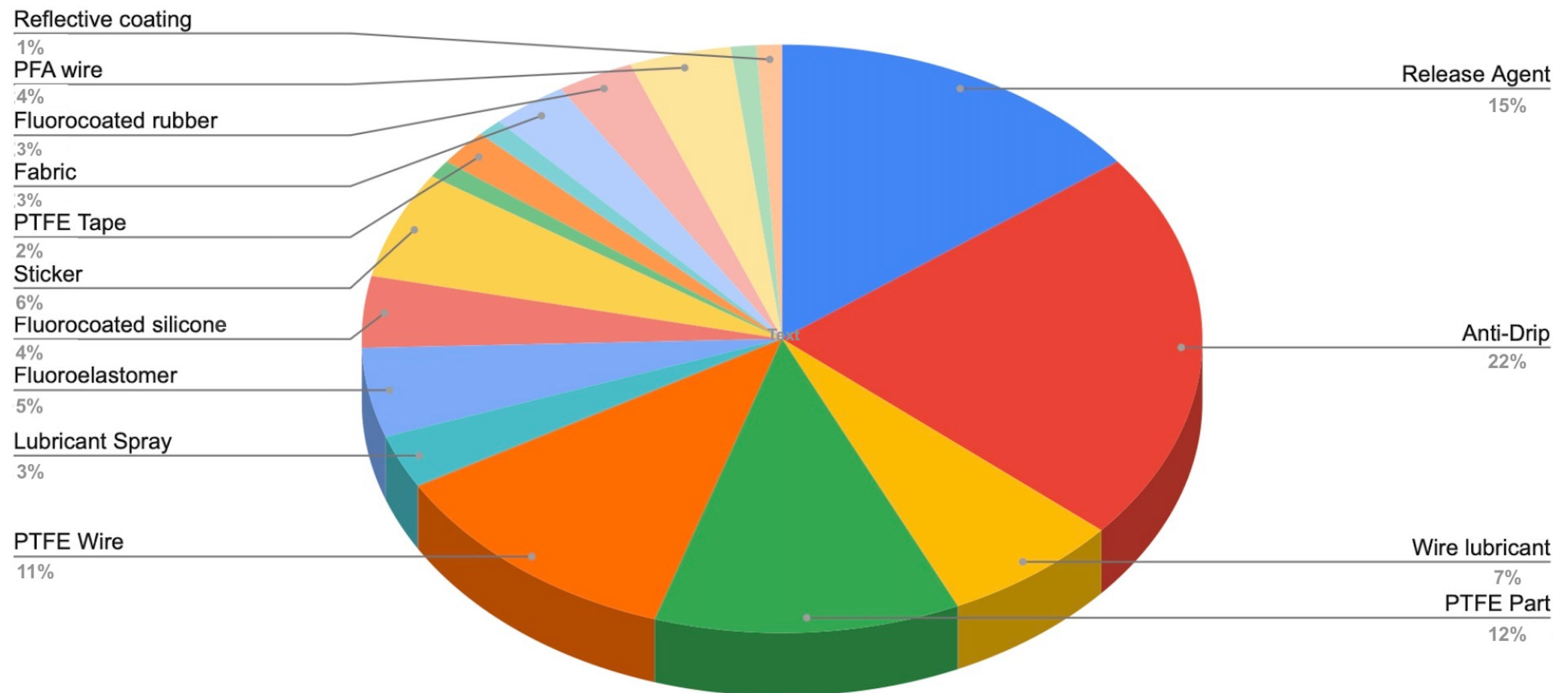
Part	F (WD-XRF) ppm	F (CB-IC) ppm
Brown foam	3023	ND
Blue wire	8779	ND
Plastic disc	16051	458



PFAS Uses Claigan - WD-XRF

- Products tested in February / August 2023

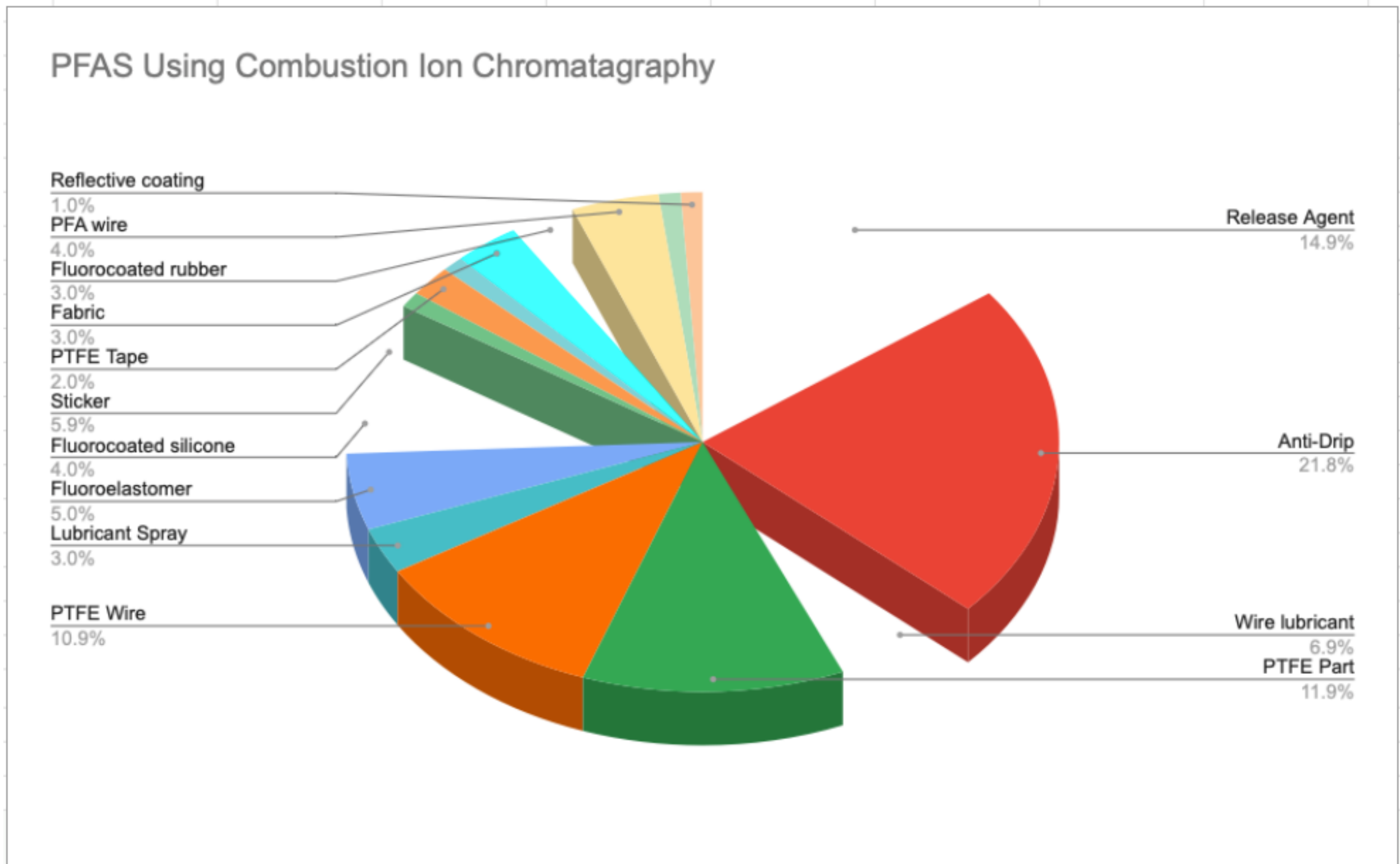
Location of PFAS in Complex Articles - 2023 Testing Data



PFAS Results

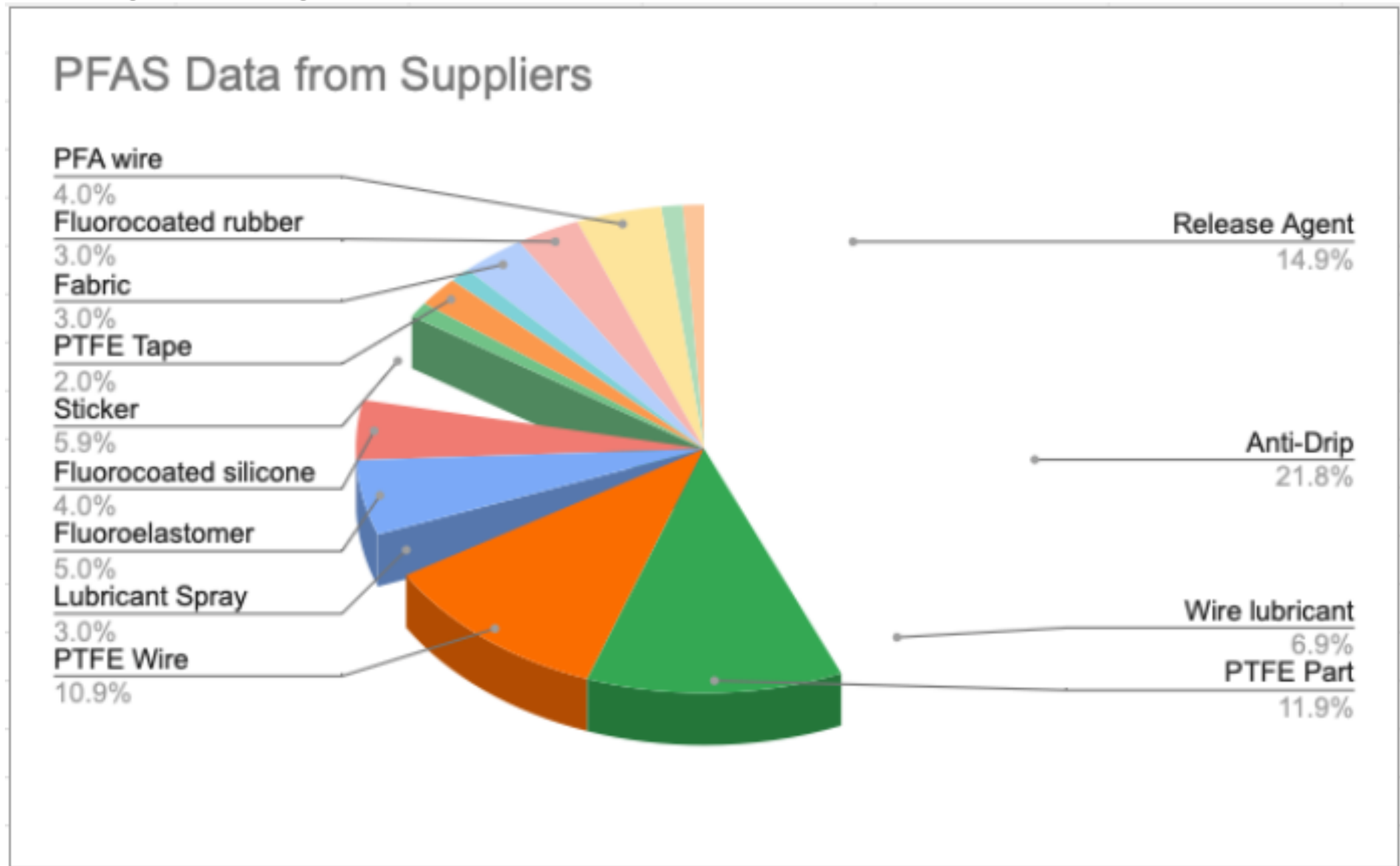
If you used CIC instead of WD-XRF

- 30% of PFAS instances would be missed with CIC



From Supplier Data Gathering

- ~50% of PFAS instances are being missed by supplier data gathering



Combustion Ion Chromatography Issues

- Two (2) Fluorine testing methods
 - Combustion - Ion Chromatography (C-IC)
 - Incinerate (combust) the product and test residual fluorine in ash



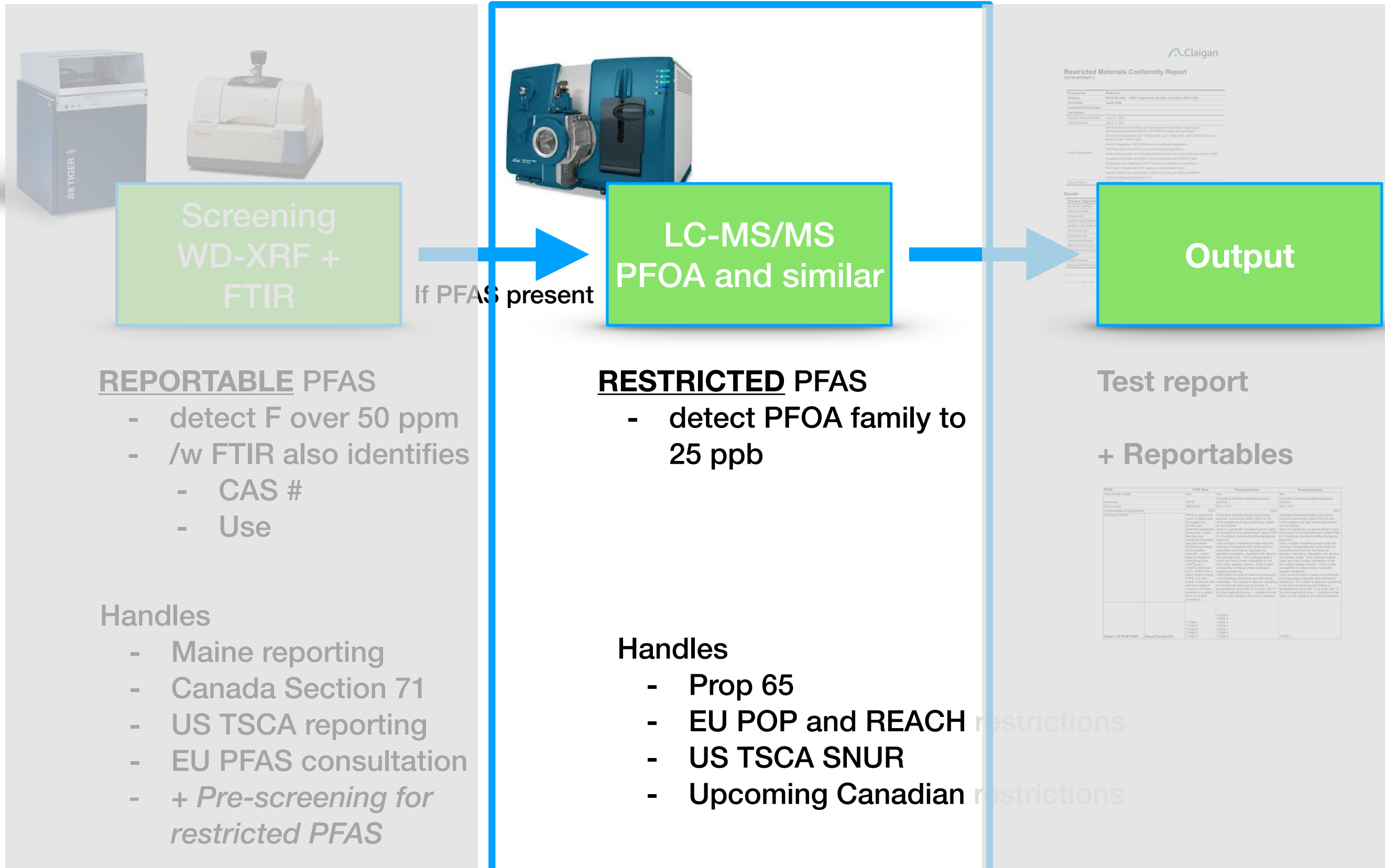
Claigan
Primary Method

Wavelength Dispersive X-Ray Fluorescence (WD-XRF)

- Directly test the fluorine content of a part



Claigan PFAS Polymer Testing



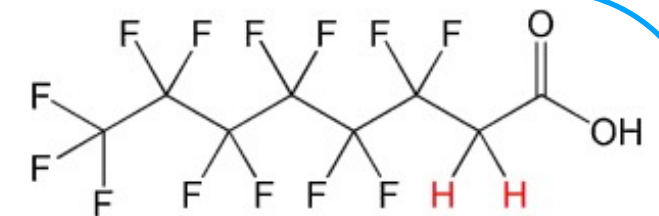
PFAS Simplified

• Non-Polymer PFAS

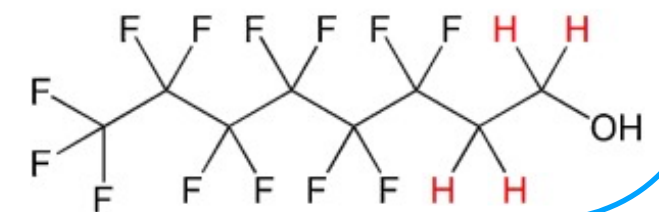
- Non-repeating PFAS (non-polymer)
- Normally **‘water soluble PFAS’**
 - **Included in polymers PFAS**

1% of Intentional Uses

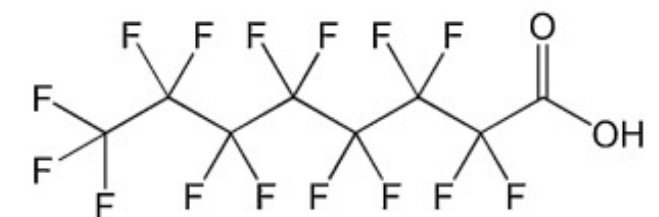
LC-MS/MS



6:2 FTCA



6:2 FTOH

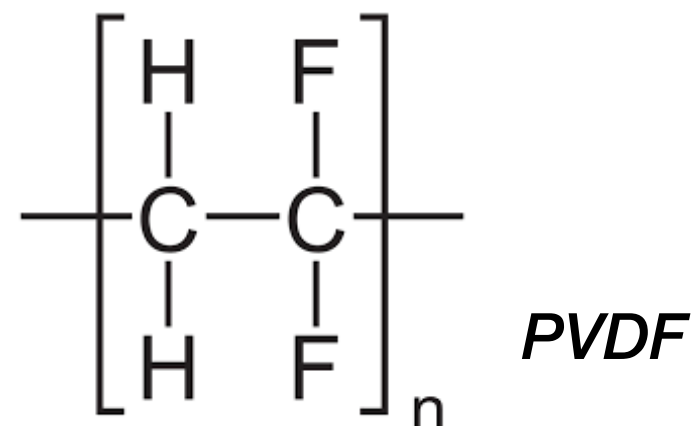
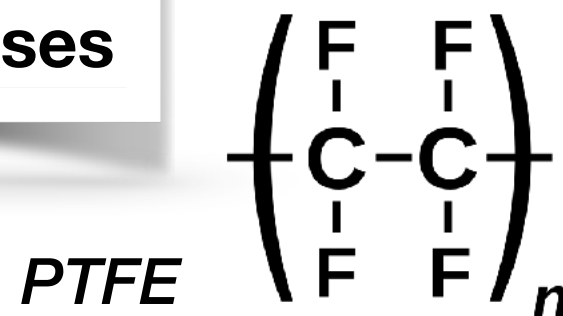


PFOA

• Polymer PFAS

- Repeating chains
- Normally the **‘intentionally added PFAS’**

99% of Intentional Uses



Claigan Submission #2

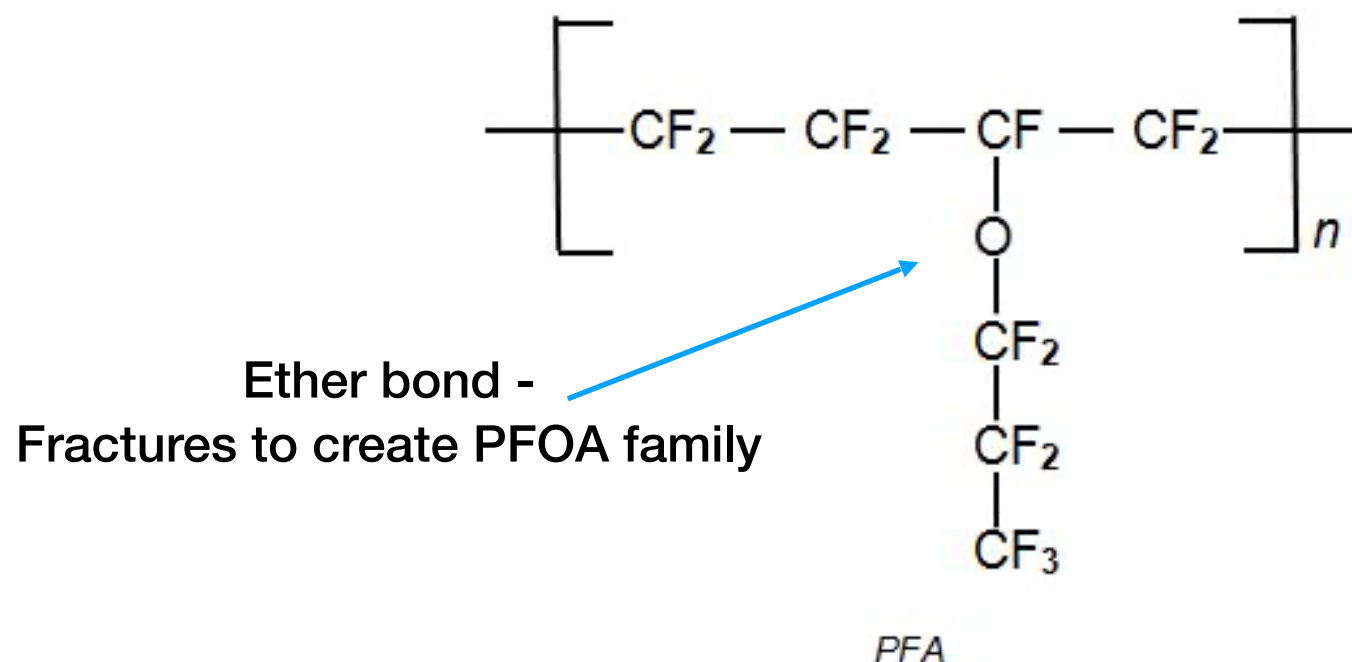
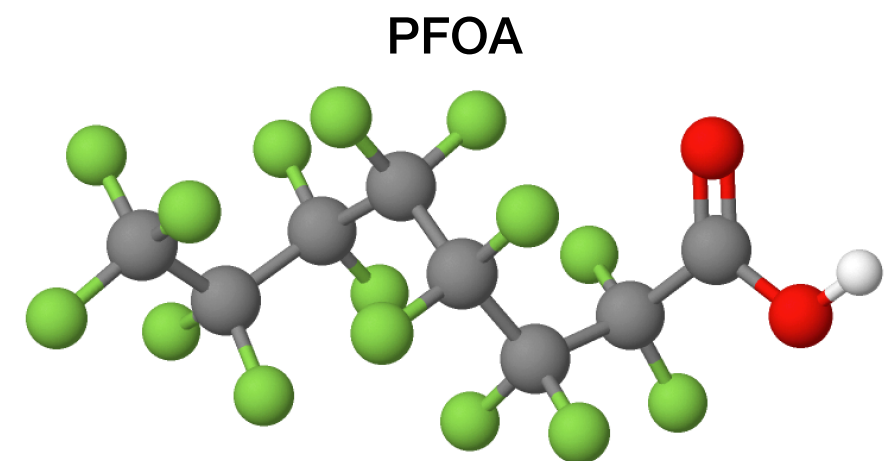
PFOA in Articles

- **Sources of PFOA (and other PFAC) in articles**

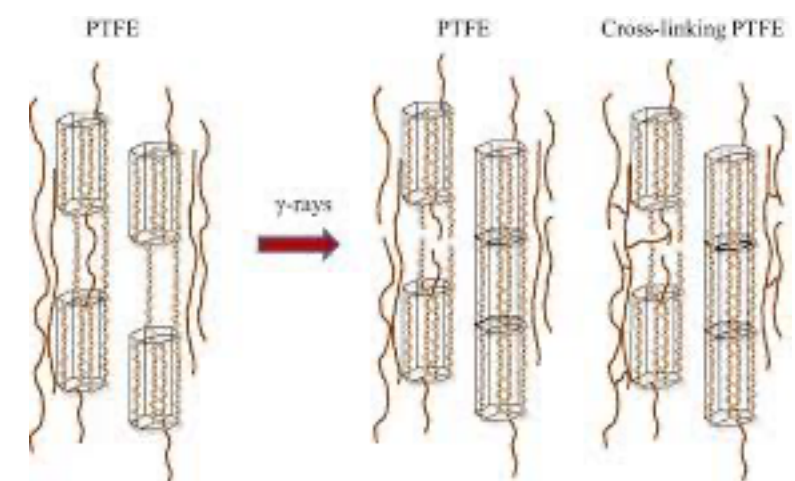
- Based on hundreds of products of data
- Explanation of reason for presence

- Examples

- Irradiation
- Ester degradation
- Surfactant during manufacturing



Irradiation of PTFE

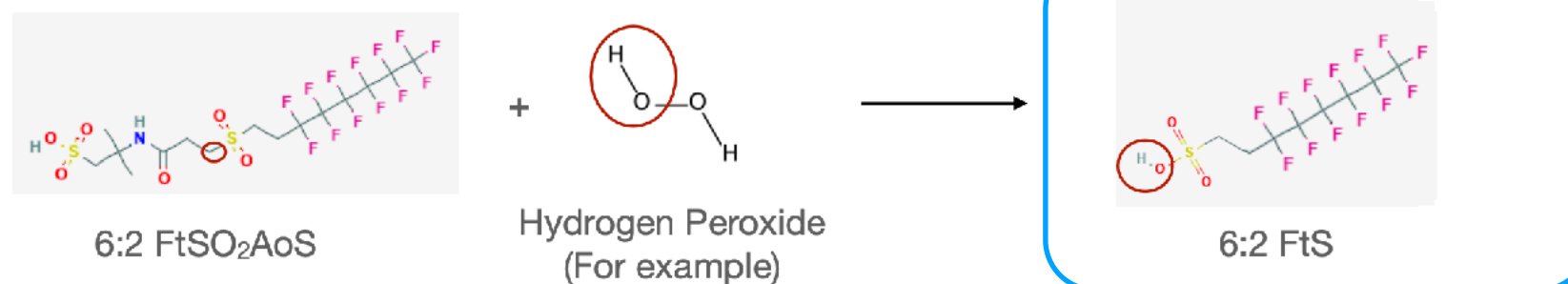


Non-Ionic Surfactant Used in Fluoroelastomers

Regular Chemical Transformation into 6:2 FTS



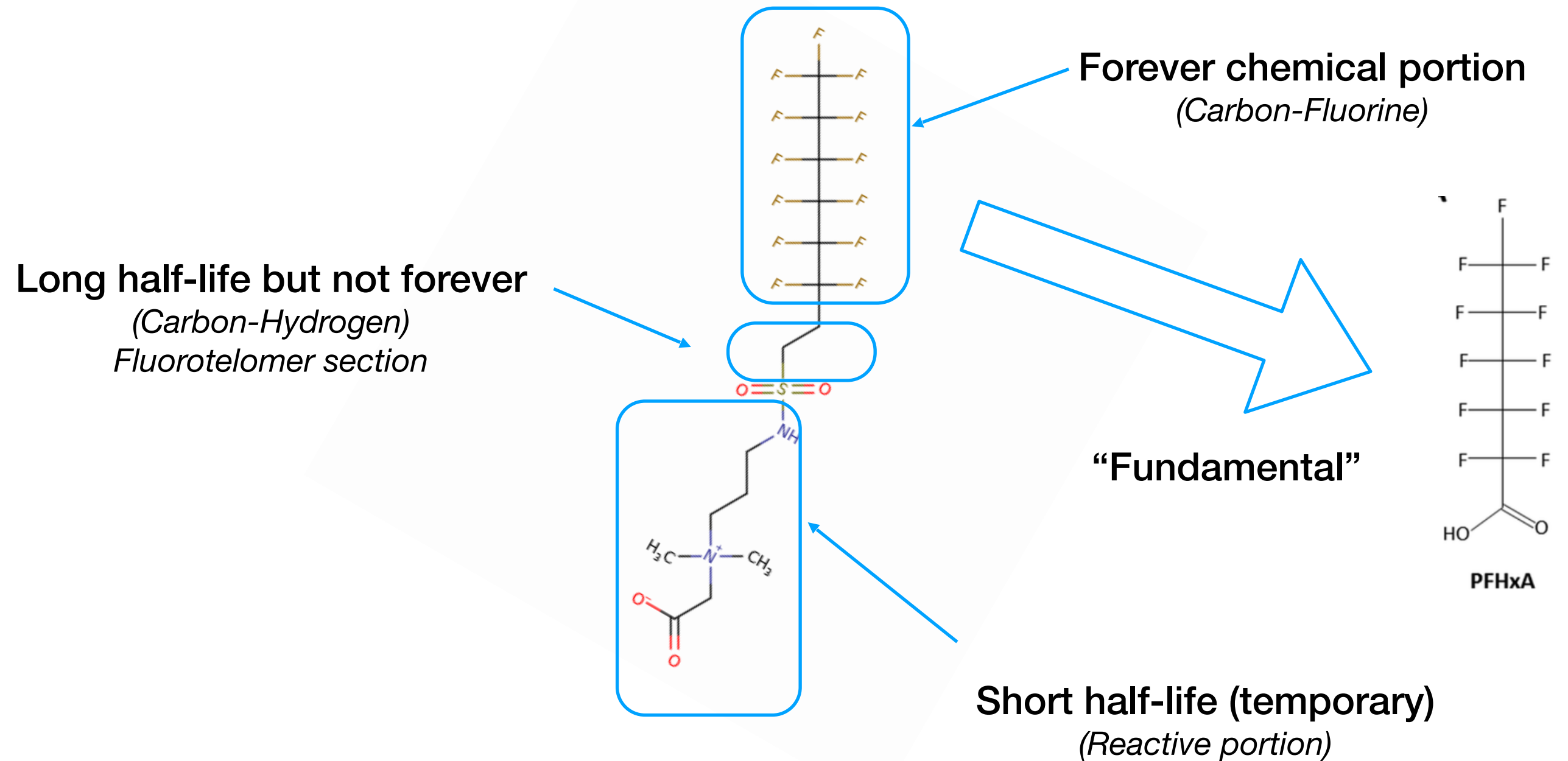
- For 6:2 FtTAoS to transform into 6:2 FtSO₂AoS it must undergo a double oxidation
- Sulphur is able to make many bonds at once. This is because it is a larger atom and therefore can have an expanded octet



Starting surfactant in
Fluoroelastomers

Measured sulphonate in end fluoroelastomer
+ some smaller PFOA family (C4-C6)

Reactive Portions of PFAS Surfactants

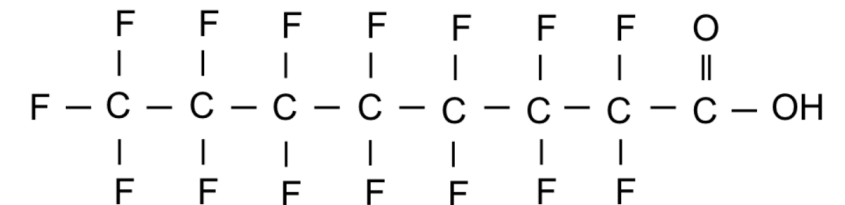


LC-MS/MS Testing

- Core “Fundamental” Substances

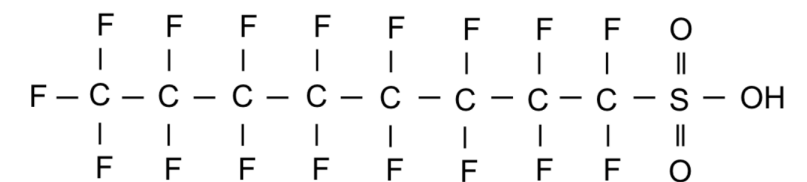
- **P25 Restrictions (P25)**

- *PFOA family (25 substances)*
- *PFOA and larger are banned in EU*
- *Shorter versions to be restricted in EU in ~2027*



- **PI3 Restrictions (PI3)**

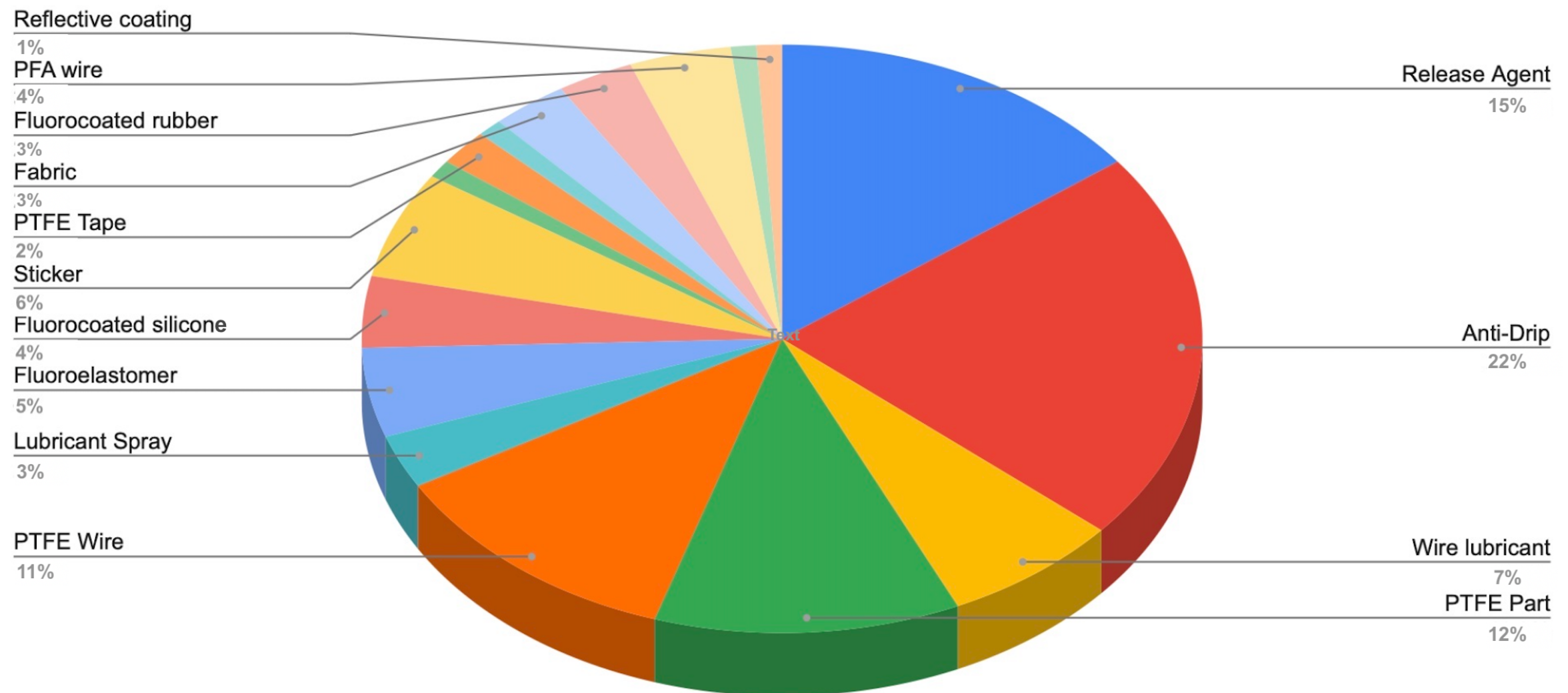
- *Add on to restricted substance testing*
- *PFOS family (13 substances)*
- *Not currently restricted in any jurisdictions*
- *Would be restricted in EU in ~2027*



PFAS Uses Claigan - WD-XRF

- Products tested in February / August 2023

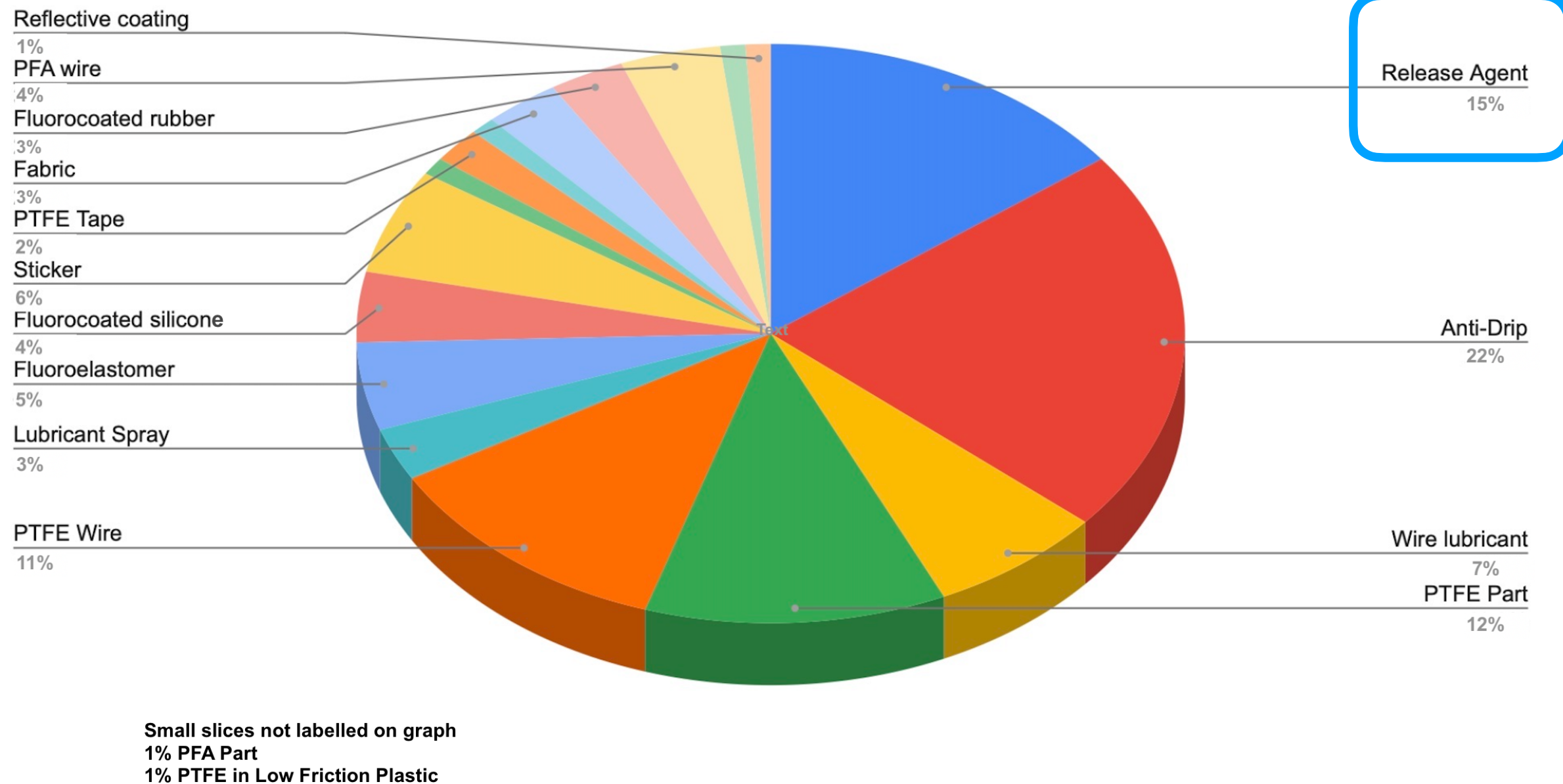
Location of PFAS in Complex Articles - 2023 Testing Data



PFAS Uses Claigan - WD-XRF

- Release agent

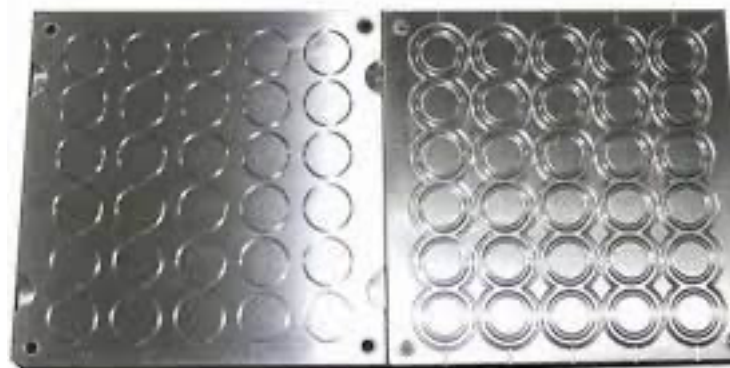
Location of PFAS in Complex Articles - 2023 Testing Data



Mold Release Agent

15% of measured occurrences

- Description
 - Aerosol fluoro coating spray applied to molds or industrial equipment
 - Normally fluorosilicone but can be PTFE dry spray
 - Very common for o-rings, gaskets, and foam.
- Forever chemicals
 - None expected.



O-ring mold

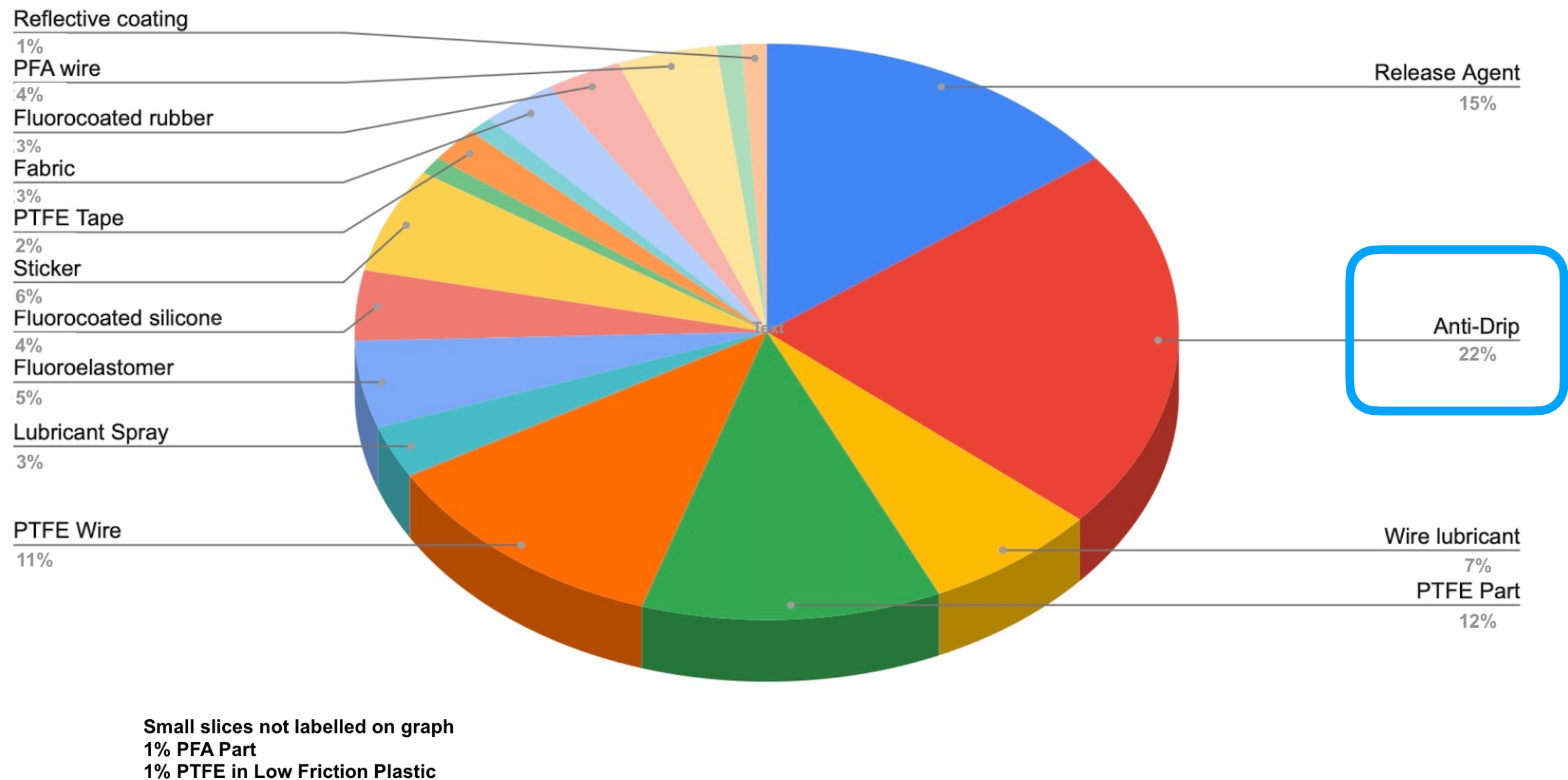


Mold Release Spray

PFAS Uses Claigan - WD-XRF

- Anti-drip additive

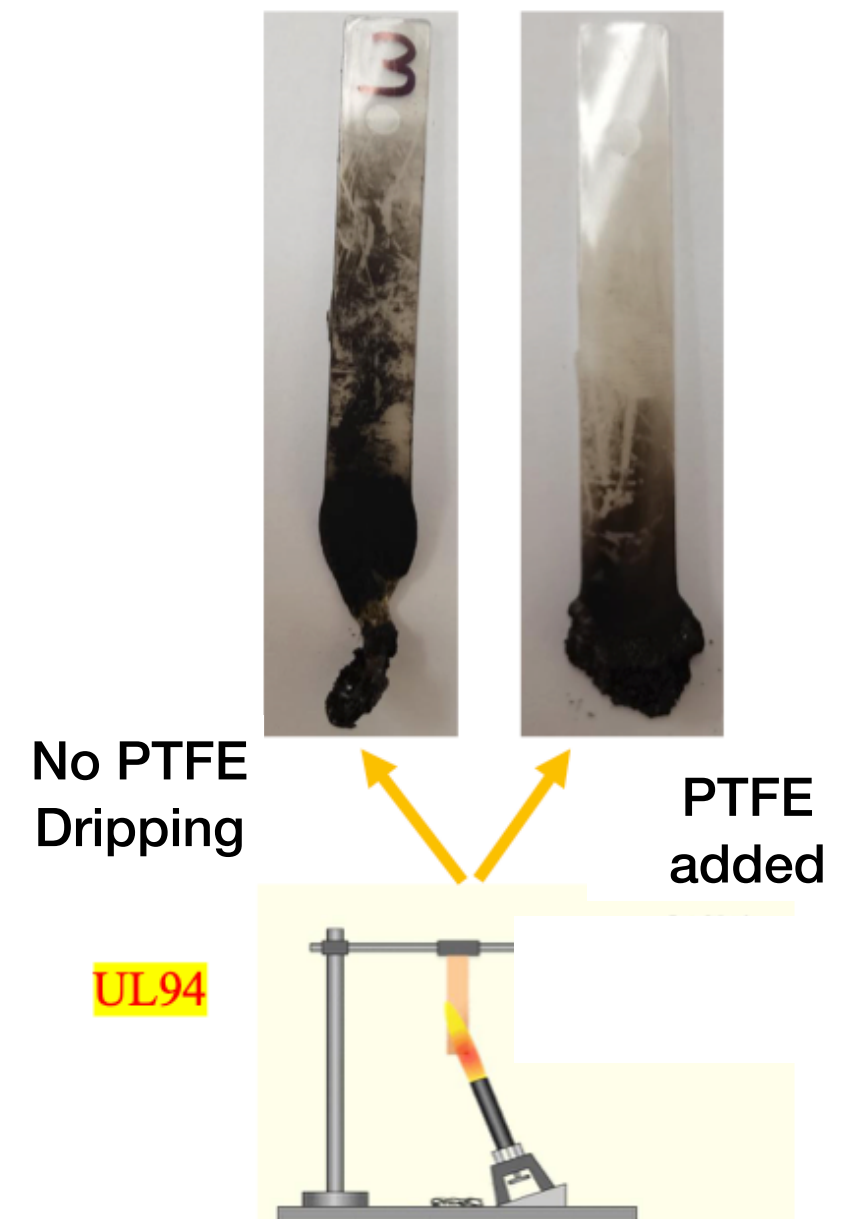
Location of PFAS in Complex Articles - 2023 Testing Data



Anti-Drip Agent

22% of measured occurrences

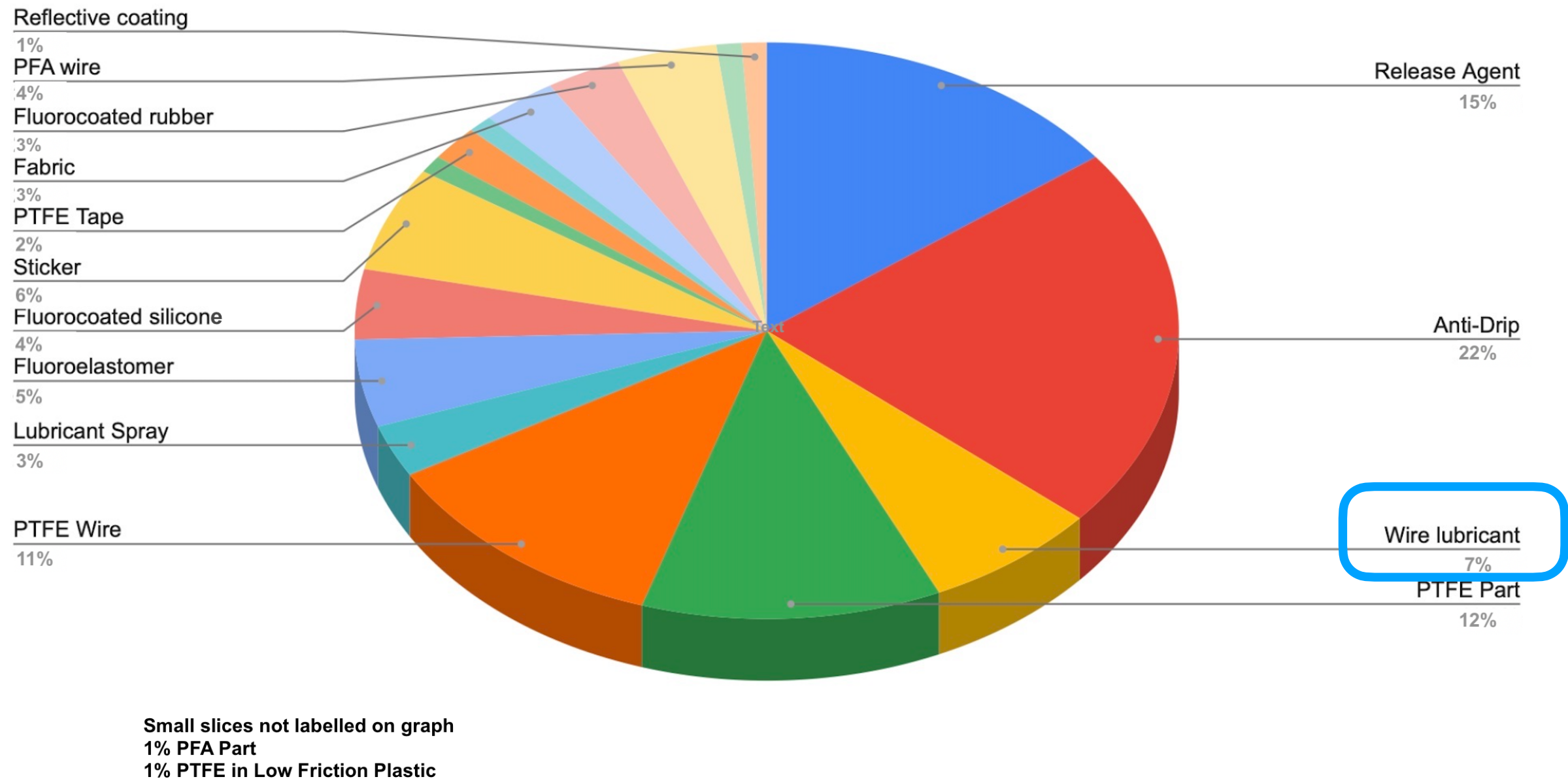
- Description
 - Flame retardant additive to prevent ‘dripping’ of hot plastic during burning.
 - More common in plastic housings of electronics requiring high flame retardancy.
 - Necessary for UL94 and similar
- Forever chemicals
 - None expected.



PFAS Uses Claigan - WD-XRF

- Wire lubricant

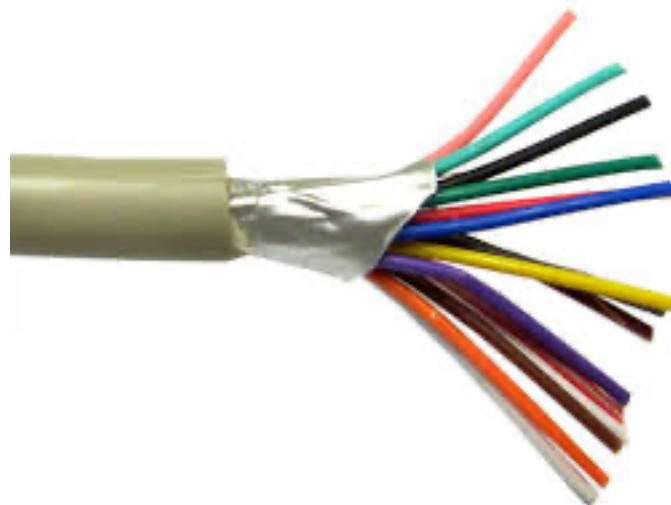
Location of PFAS in Complex Articles - 2023 Testing Data



Wire Lubricant

7% of measured occurrences

- Description
 - Aerosol fluoro coating spray applied to internal wiring or their assembly equipment.
 - Often fluorosilicone but can be PTFE dry spray
 - To improve flexibility of cable and reduce wear
 - In some case may be related to the assembly equipment of the wire
- Forever chemicals
 - None expected

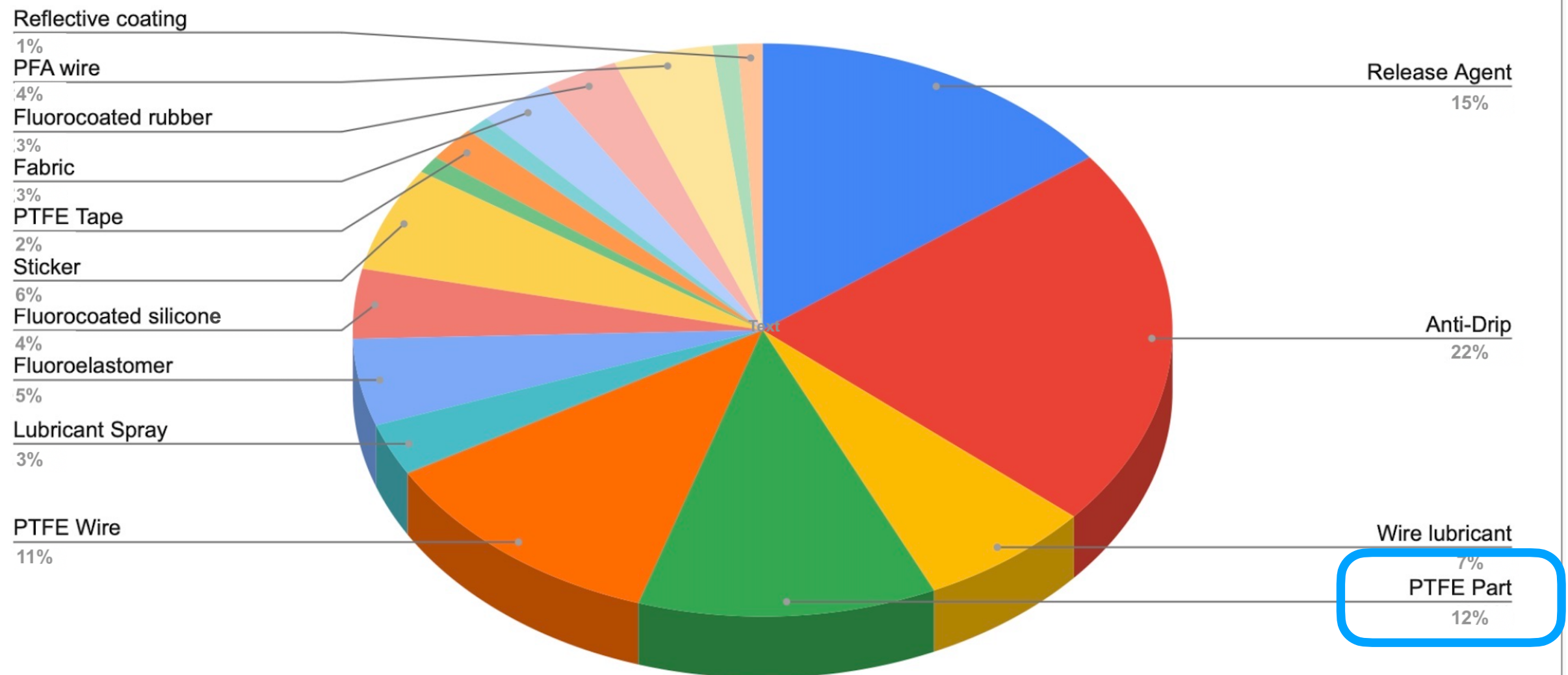


Aerosol Fluoro Spray

PFAS Uses Claigan - WD-XRF

- PTFE Part

Location of PFAS in Complex Articles - 2023 Testing Data



PTFE part

12% of measured occurrences

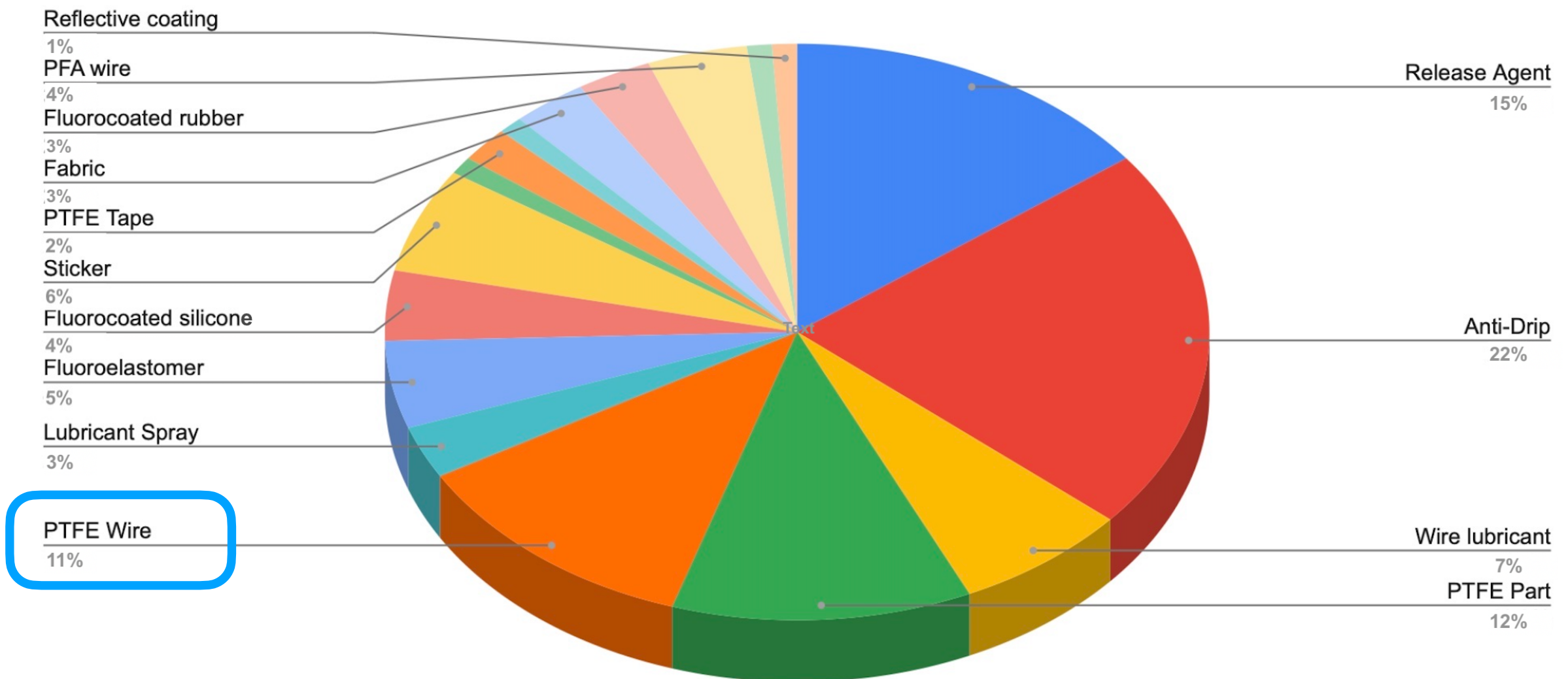
- Description
 - PTFE used as a solid part
 - Excluding wire insulation and tape
 - Very common in applications requiring low friction or high temperature performance
- Forever chemicals
 - None expected



PFAS Uses Claigan - WD-XRF

- PTFE Wire

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

11% of measured occurrences

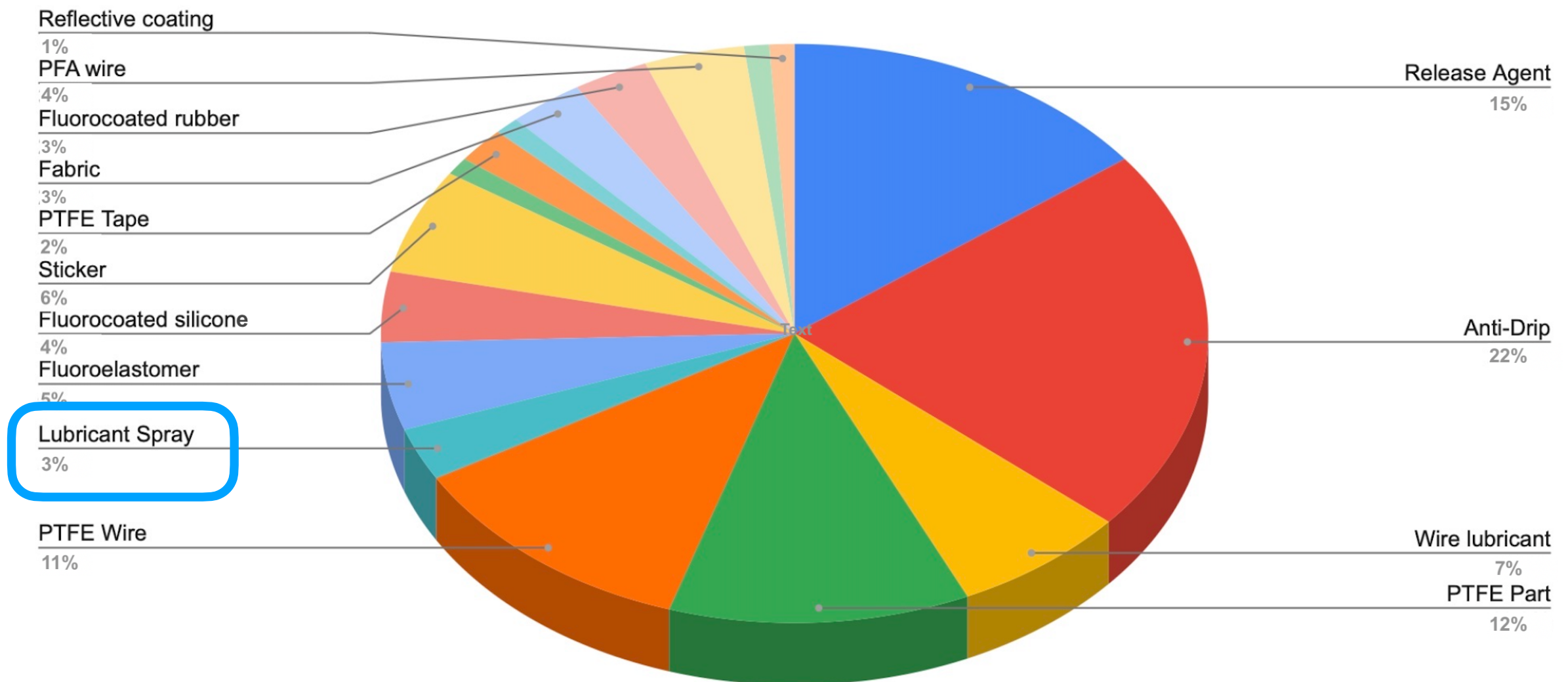
- Description
 - PTFE used as a wire insulator
 - Very common in wiring applications requiring low friction or high temperature performance
- Forever chemicals
 - None expected
 - Note - in most situations where PFOA family is measured in 'PTFE' wire, the wire is identified to be PFA (after further investigation)



PFAS Uses Claigan - WD-XRF

- Lubricant Spray

Location of PFAS in Complex Articles - 2023 Testing Data



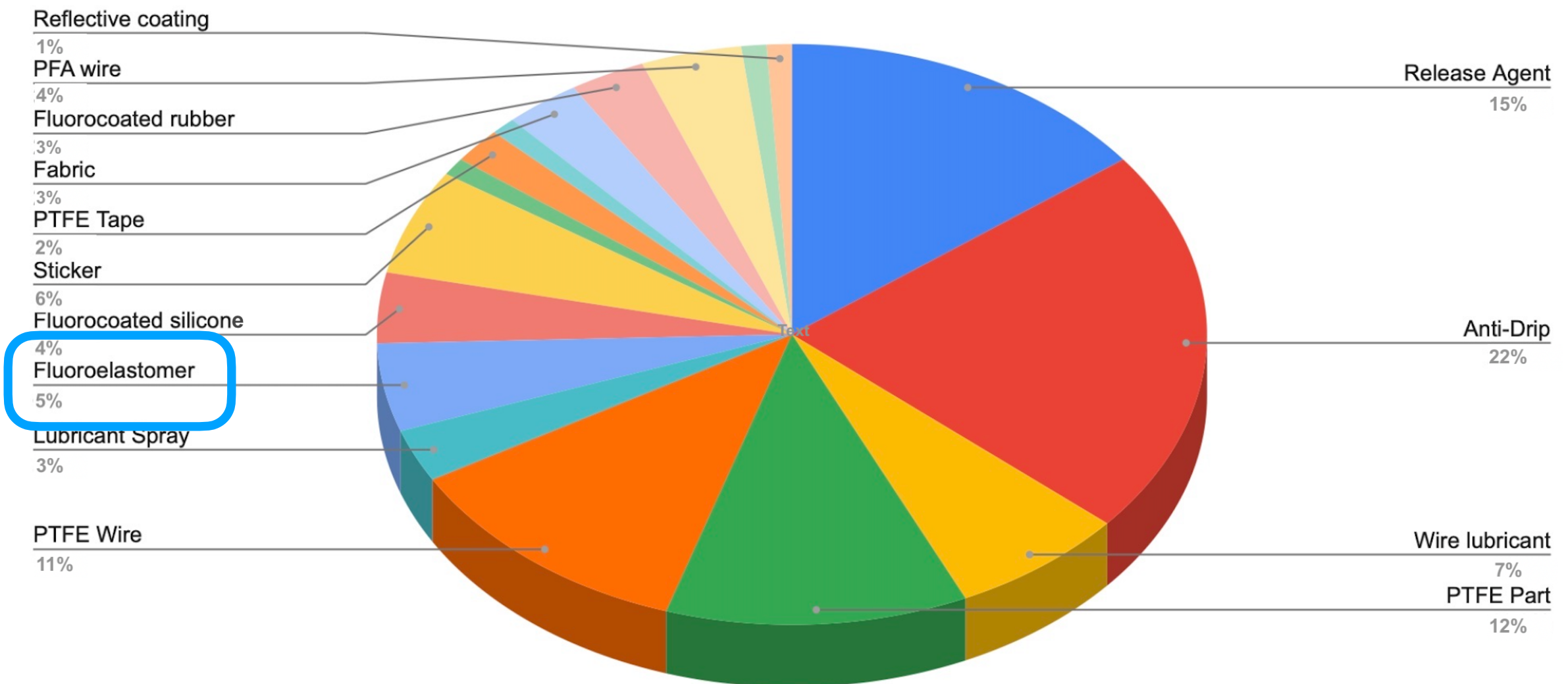
Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

-
- Super Lube**
- DRI-FILM**
- Lubricant**
- With SYNCOLON® P.T.F.E.
- KEEP OUT OF REACH OF CHILDREN
DANGER: EXTREMELY FLAMMABLE
 HARMFUL OR FATAL IF SWALLOWED
 CONTENTS UNDER PRESSURE
 See other cautions on Back Panel
- NET WT. 0.2 (312 grams)
- Page 1

PFAS Uses Claigan - WD-XRF

- Fluoroelastomer

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph

1% PFA Part

1% PTFE in Low Friction Plastic

5% of measured occurrences

- Description
 - Includes
 - Fluoroelastomers (FKM or 'Viton')
 - Perfluoroelastomers (FFKM or 'Kalrez')
 - Fluorosilicone (FVMQ)
 - Fluororubbers with significant temperature and chemical resistance.
 - Very common o-ring / gasket material
- Forever chemicals
 - Commonly contain 6:2 FTS from emulsion surfactant
 - Occasionally short chain perfluorocarboxylates (C4 to C7) from further break down of 6:2 FTS

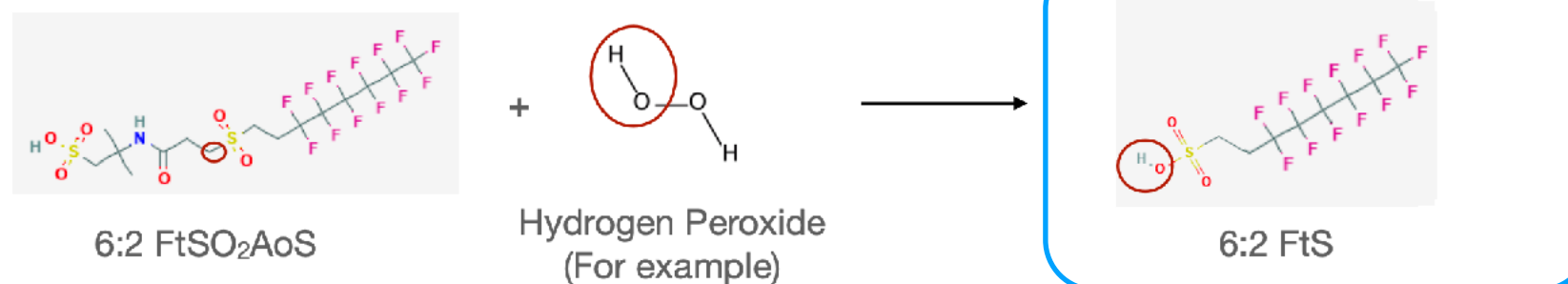


Non-Ionic Surfactant Used in Fluoroelastomers

Regular Chemical Transformation into 6:2 FTS



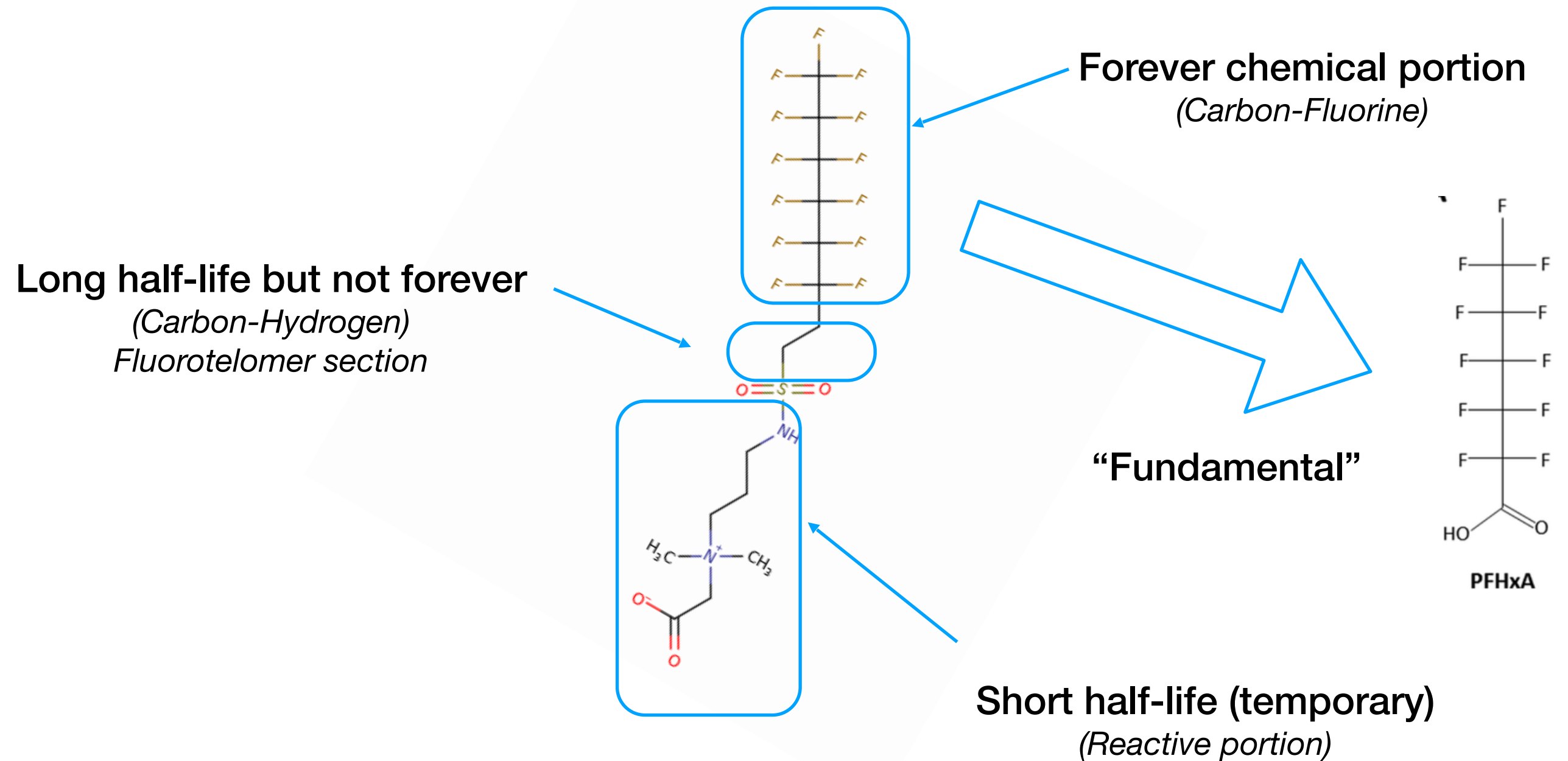
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- Sulphur is able to make many bonds at once. This is because it is a larger atom and therefore can have an expanded octet



Starting surfactant in
Fluoroelastomers

Measured sulphonate in end fluoroelastomer
+ some smaller PFOA family (C4-C6)

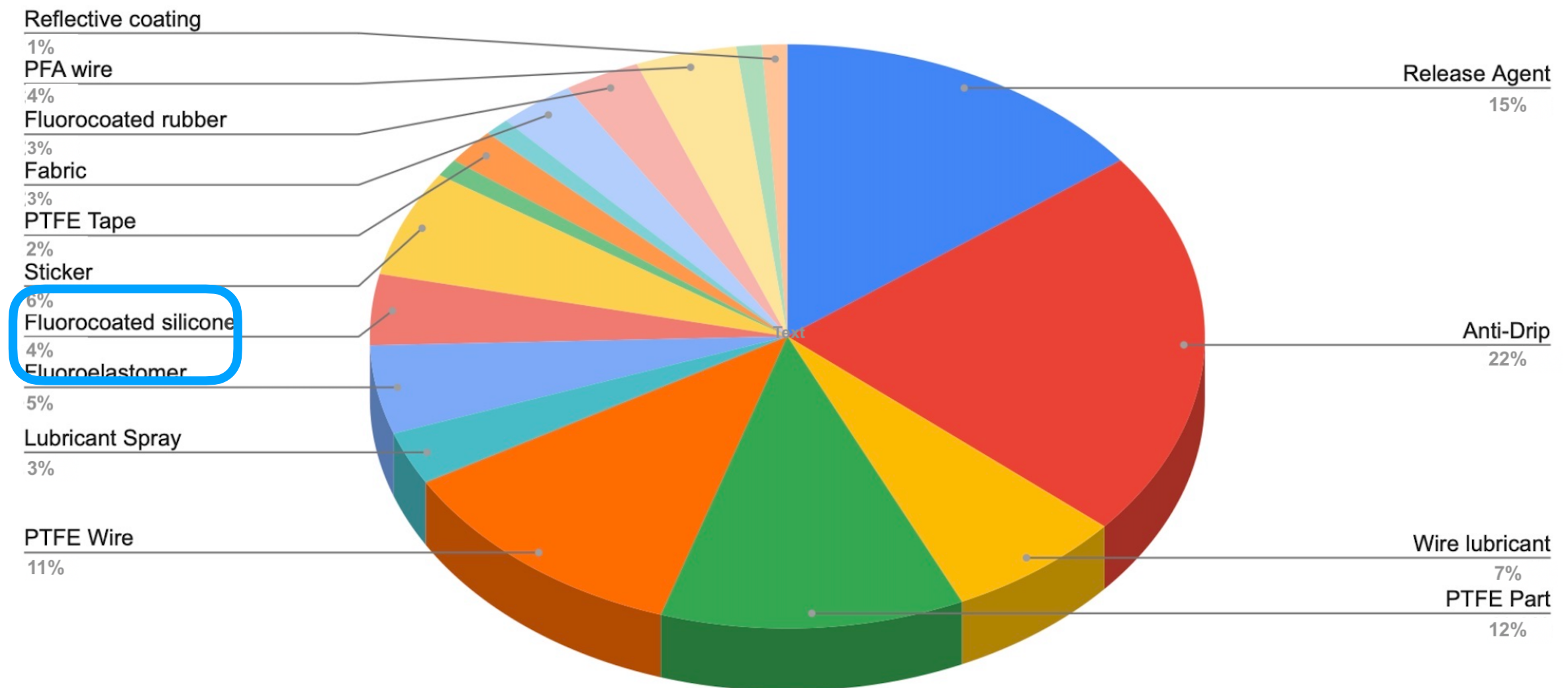
Reactive Portions of PFAS Surfactants



PFAS Uses Claigan - WD-XRF

- Fluorocoated silicone rubber

Location of PFAS in Complex Articles - 2023 Testing Data



Fluoro-coated silicone

4% of measured occurrences

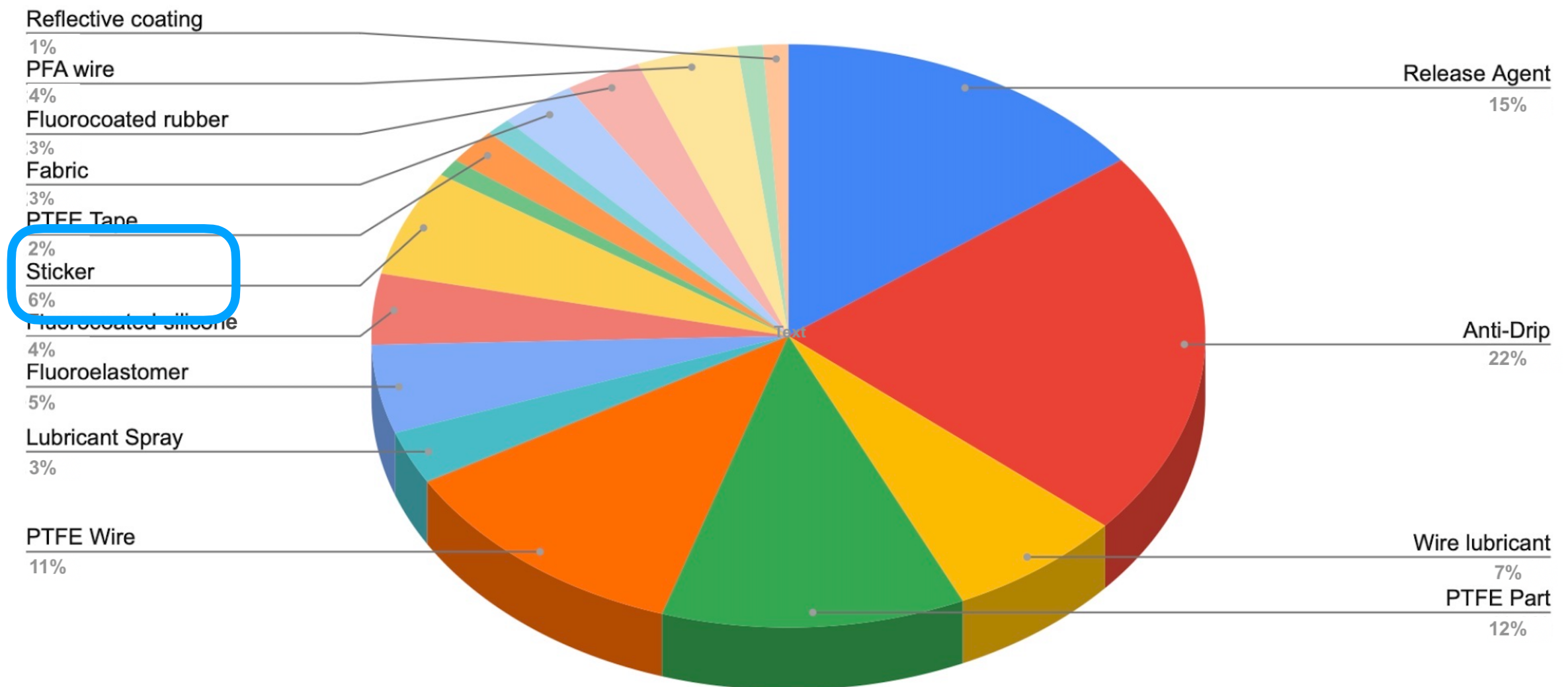
- Description
 - Fluorocoating on silicone rubber
 - Very commonly used to add oil resistance or reduced friction to silicone rubber
 - Especially human contacting silicone such as touch pads
- Forever chemicals
 - None expected to be measured.



PFAS Uses Claigan - WD-XRF

- Stickers

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

6% of measured occurrences

- Description
 - Two (2) situations
 - Fluoro-coating for environmental resistance, or
 - Fluoro contaminant in adhesive
 - Fluoro contaminant version is either from
 - Fluorosilicone release liner of sticker, or
 - Surfactant to improve adhesion of adhesive

- Forever chemicals
 - Under review.

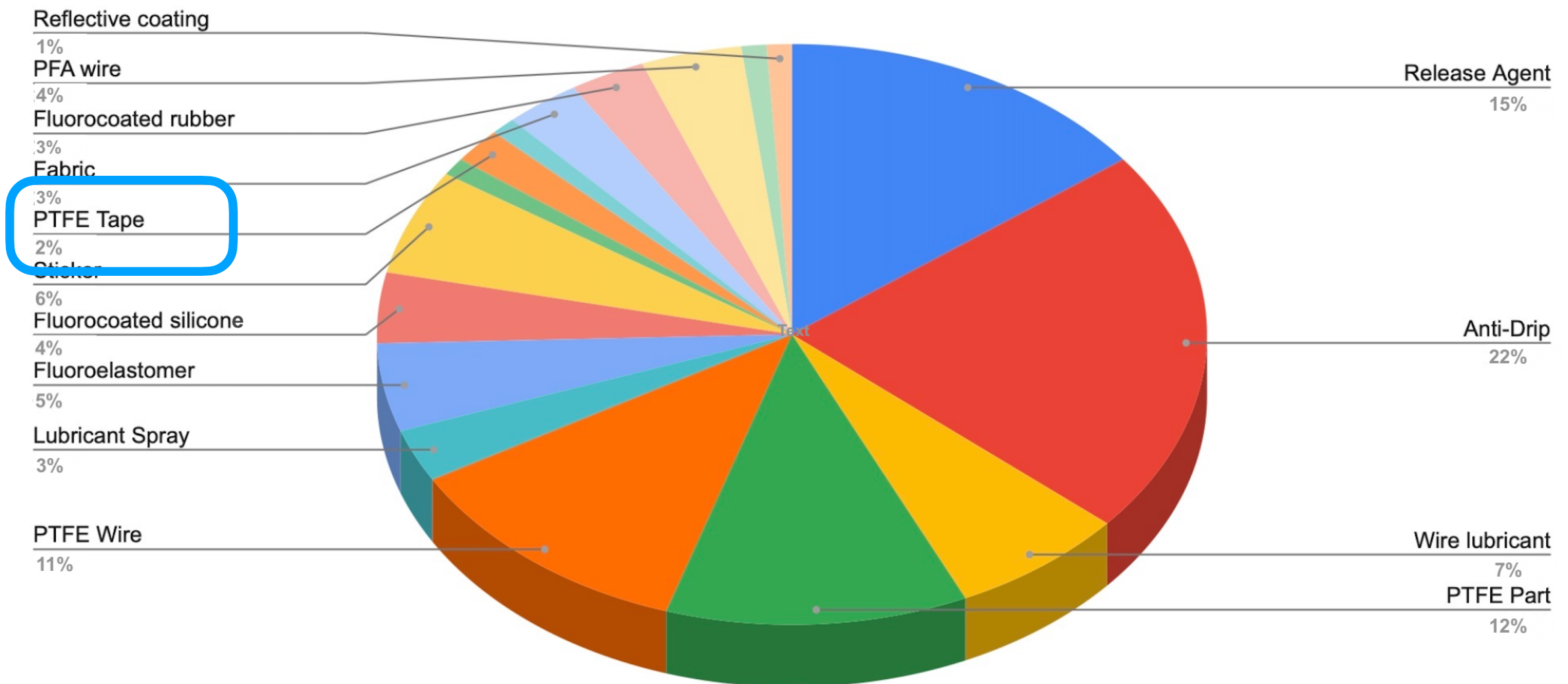


(Representative)

PFAS Uses Claigan - WD-XRF

- PTFE Tape

Location of PFAS in Complex Articles - 2023 Testing Data



PTFE Tape

2% of measured occurrences

- Description
 - PTFE tape
 - Normally used for joining two fluid or gas components.
 - Also common in medical devices

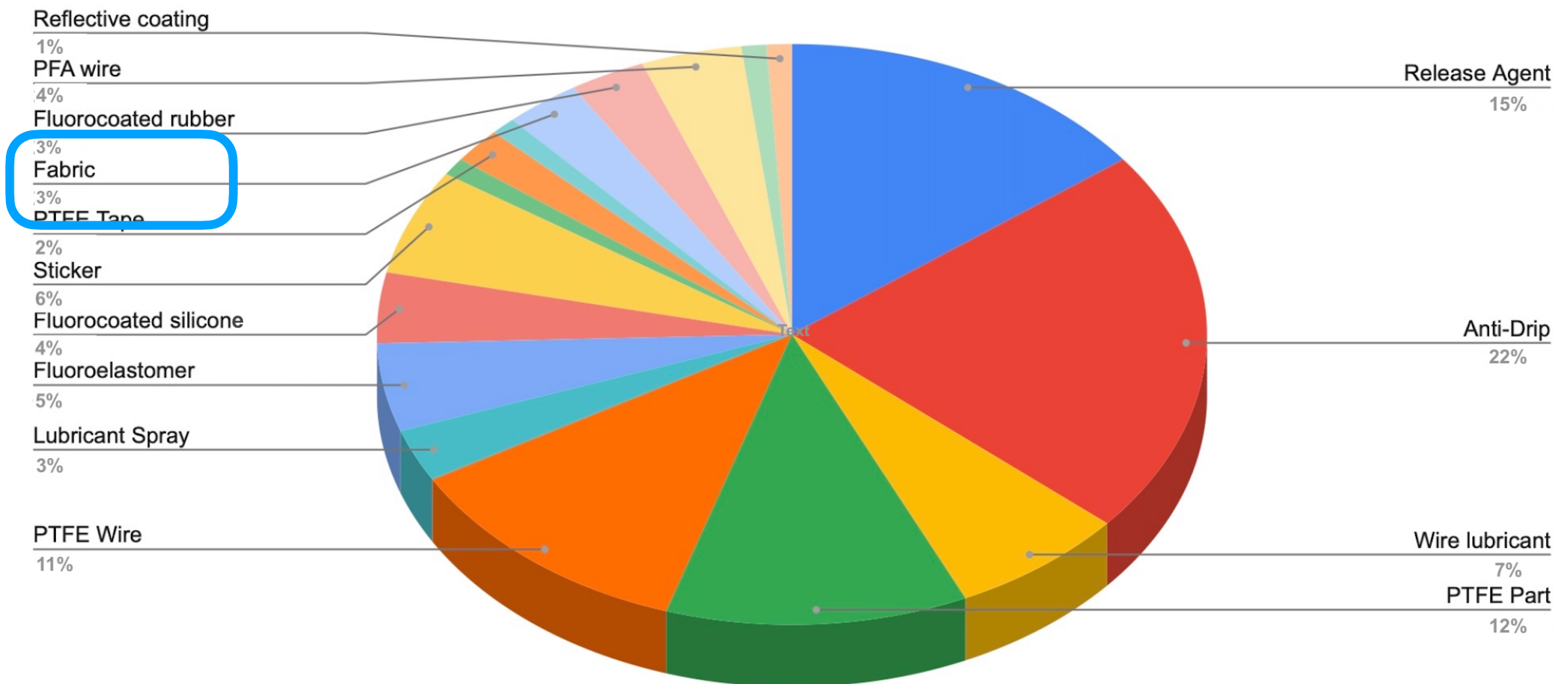


- Forever chemicals
 - Commonly contains full range of perfluorocarboxylates (PFOA family)

PFAS Uses Claigan - WD-XRF

- Fabric

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

3% of measured occurrences

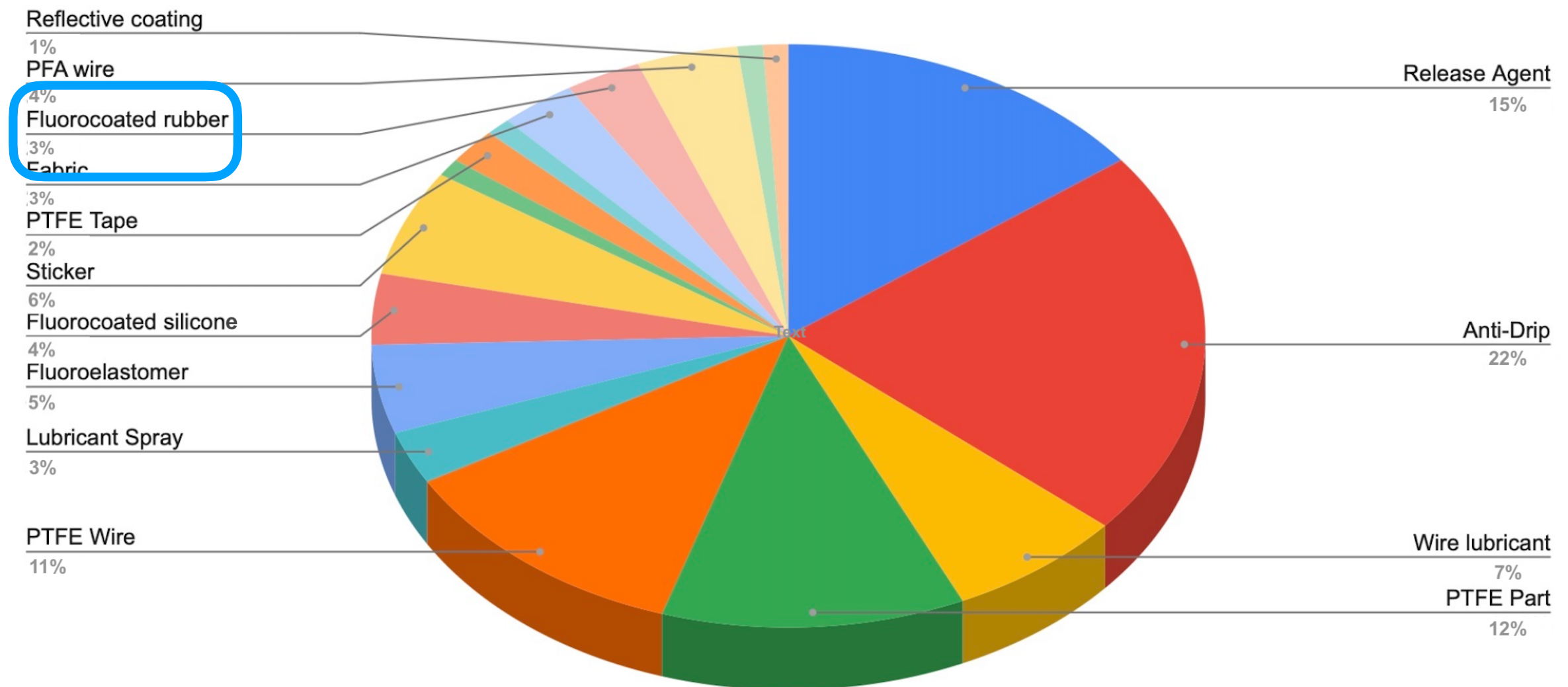
- Description
 - Fluoroacrylate coating of fabric for water and stain resistance
 - Common in
 - Outdoor textiles, and
 - Washing / country of origin labels
- Forever chemicals
 - Commonly contains full range of perfluorocarboxylates (PFOA family)



PFAS Uses Claigan - WD-XRF

- Fluoro-coated rubber

Location of PFAS in Complex Articles - 2023 Testing Data



Fluoro-coated rubber

3% of measured occurrences

- Description
 - Fluoro-coated nitrile rubber (or similar)
 - Provides acid resistance or reduced friction to nitrile rubber
 - Common in medical or pharmaceutical industry

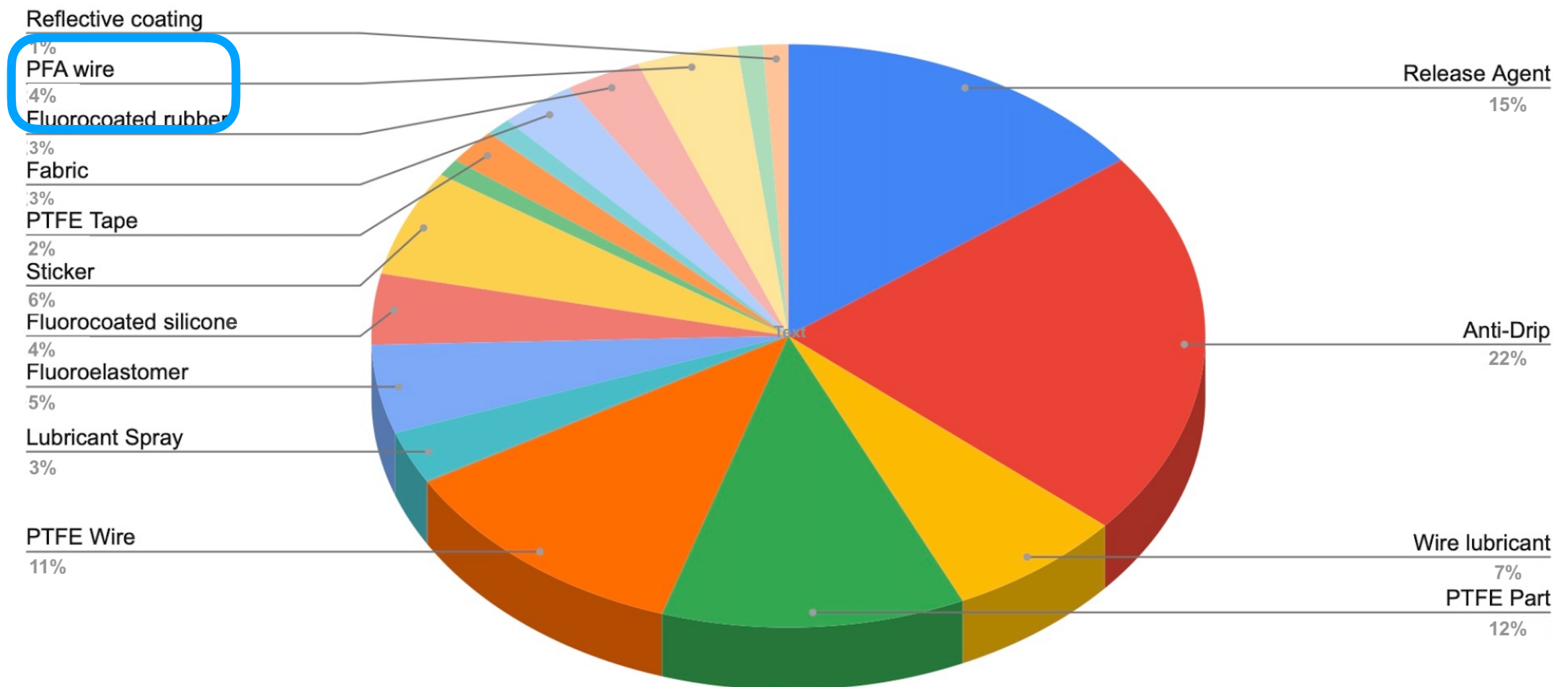


- Forever chemicals
 - None expected.

PFAS Uses Claigan - WD-XRF

- PFA Wire

Location of PFAS in Complex Articles - 2023 Testing Data



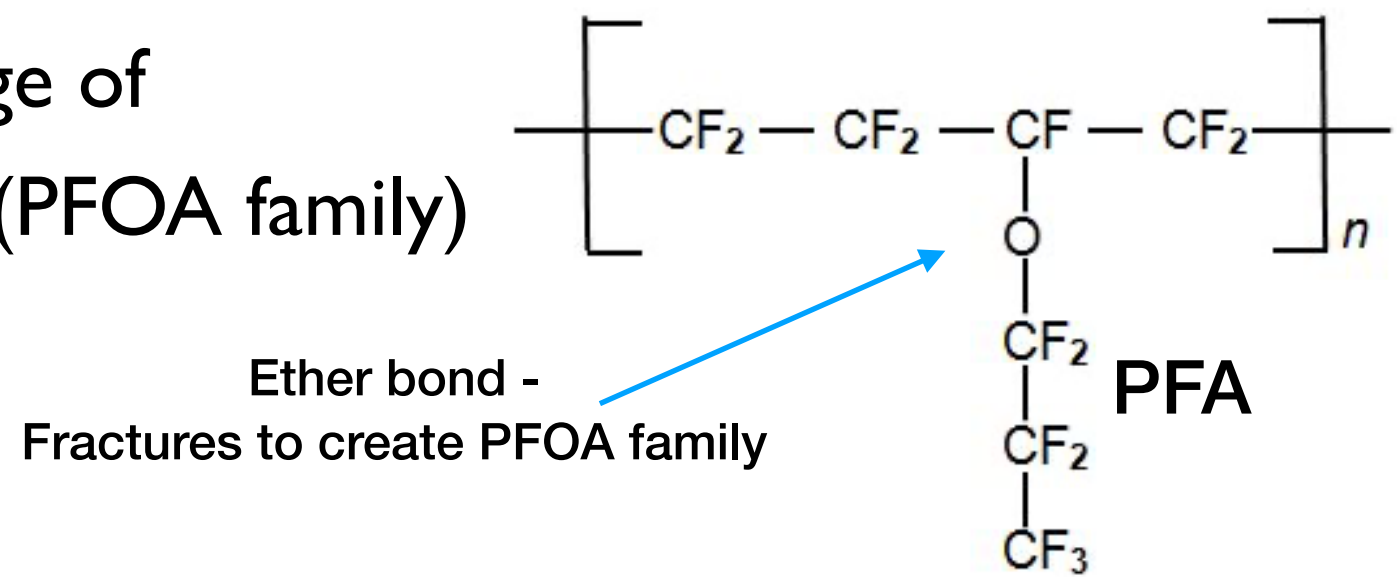
Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

4% of measured occurrences

- Description
 - Perfluoroxy alkane (PFA) insulation for wires
 - Very common in
 - dense electronics requiring high flexibility and high temperature resistance, and
 - medical devices requiring high flexibility



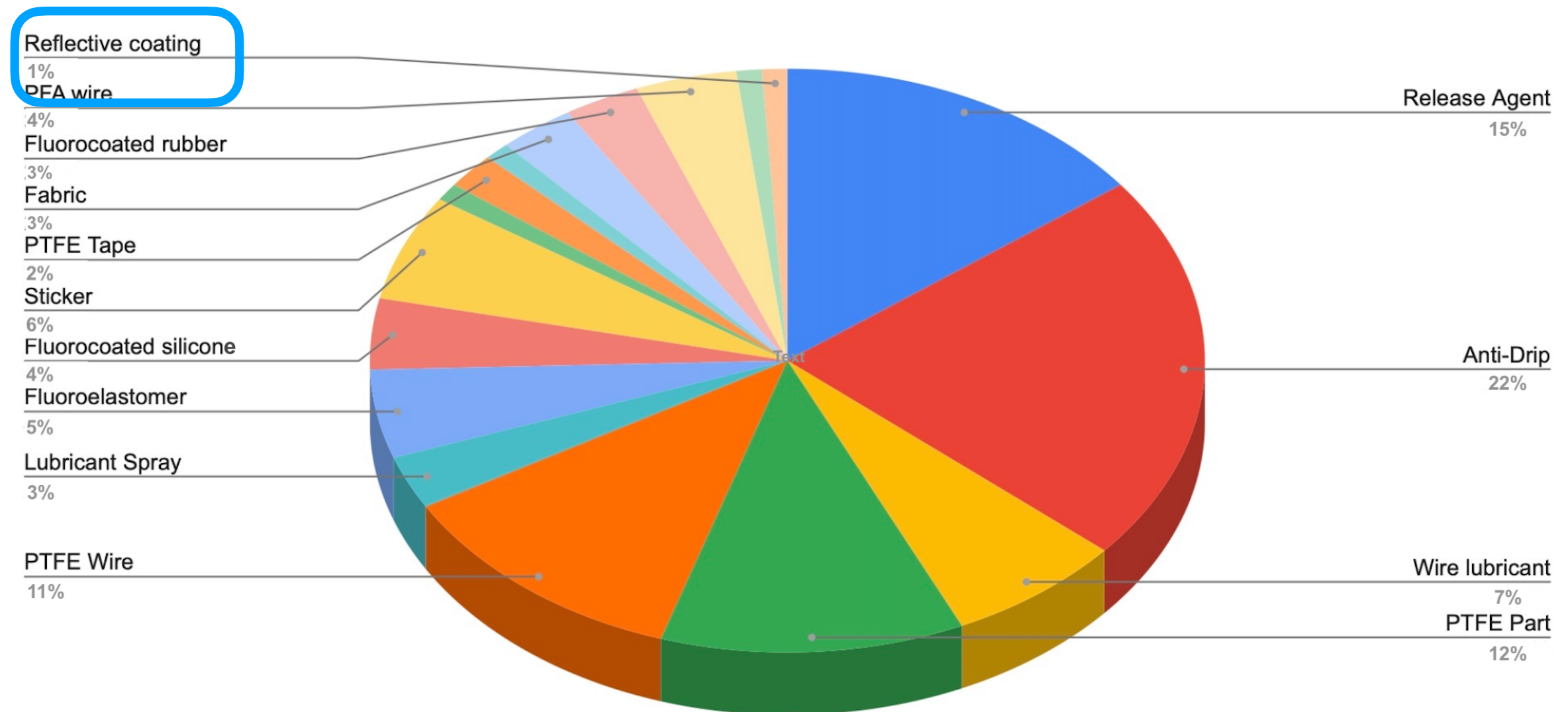
- Forever chemicals
 - Often contains full range of
 - perfluorocarboxylates (PFOA family)



PFAS Uses Claigan - WD-XRF

- Anti-reflective / anti-smudge coating

Location of PFAS in Complex Articles - 2023 Testing Data



Small slices not labelled on graph
1% PFA Part
1% PTFE in Low Friction Plastic

Anti-reflective - Anti-smudge

1% of measured occurrences

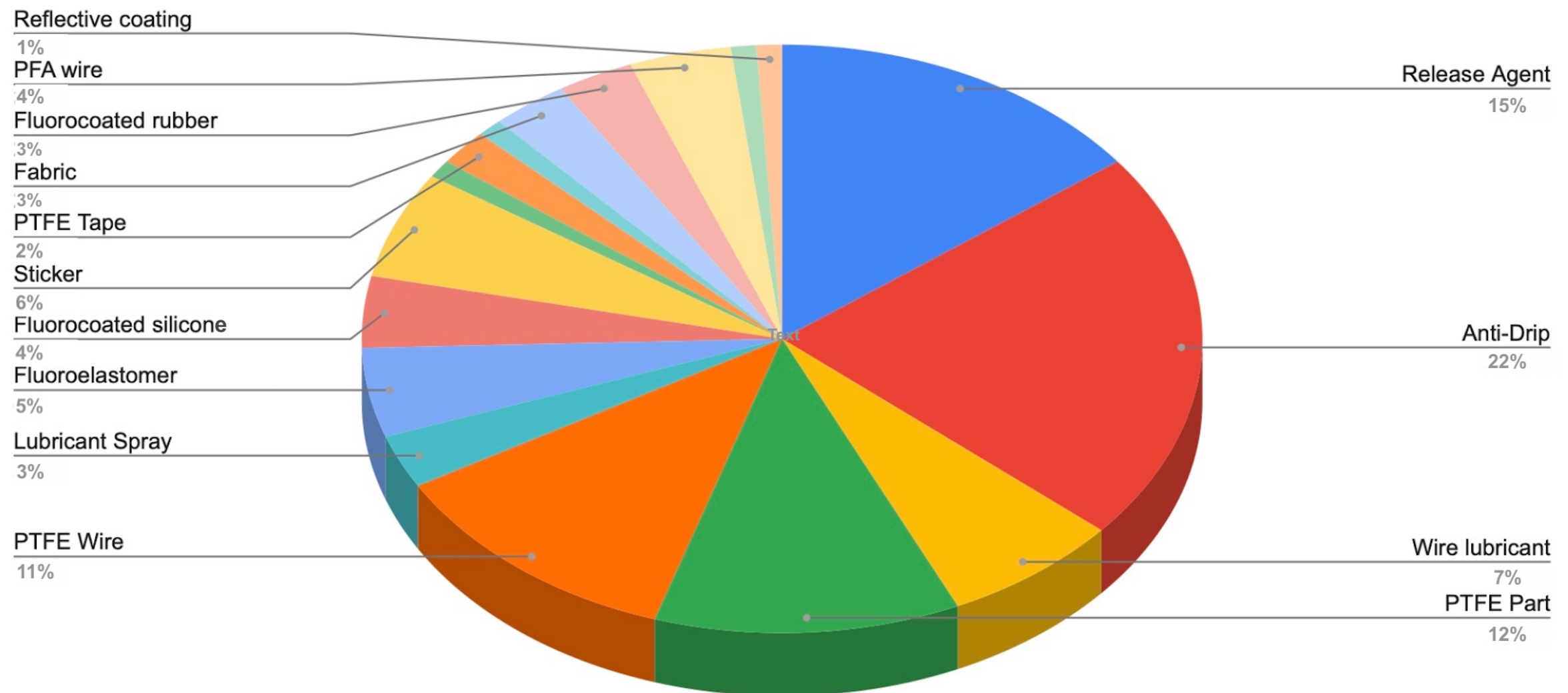
- Description
 - Anti-reflective / anti-smudge (anti-fog) fluoro-coating
 - Very common in
 - Electronics displays
 - Eyewear
- Forever chemicals
 - None expected.



PFAS Uses Claigan - WD-XRF

- Products tested in February / August 2023

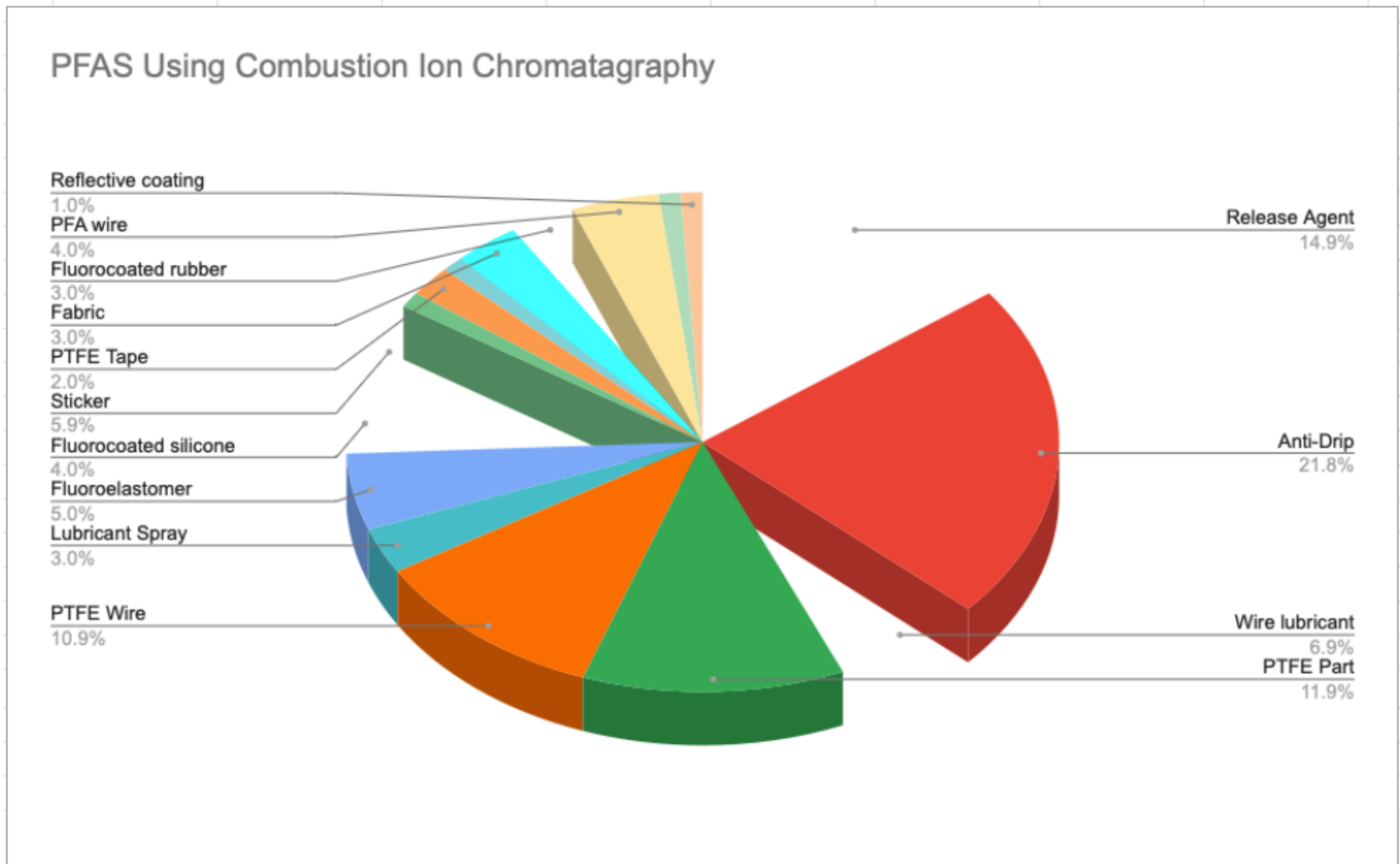
Location of PFAS in Complex Articles - 2023 Testing Data



PFAS Results

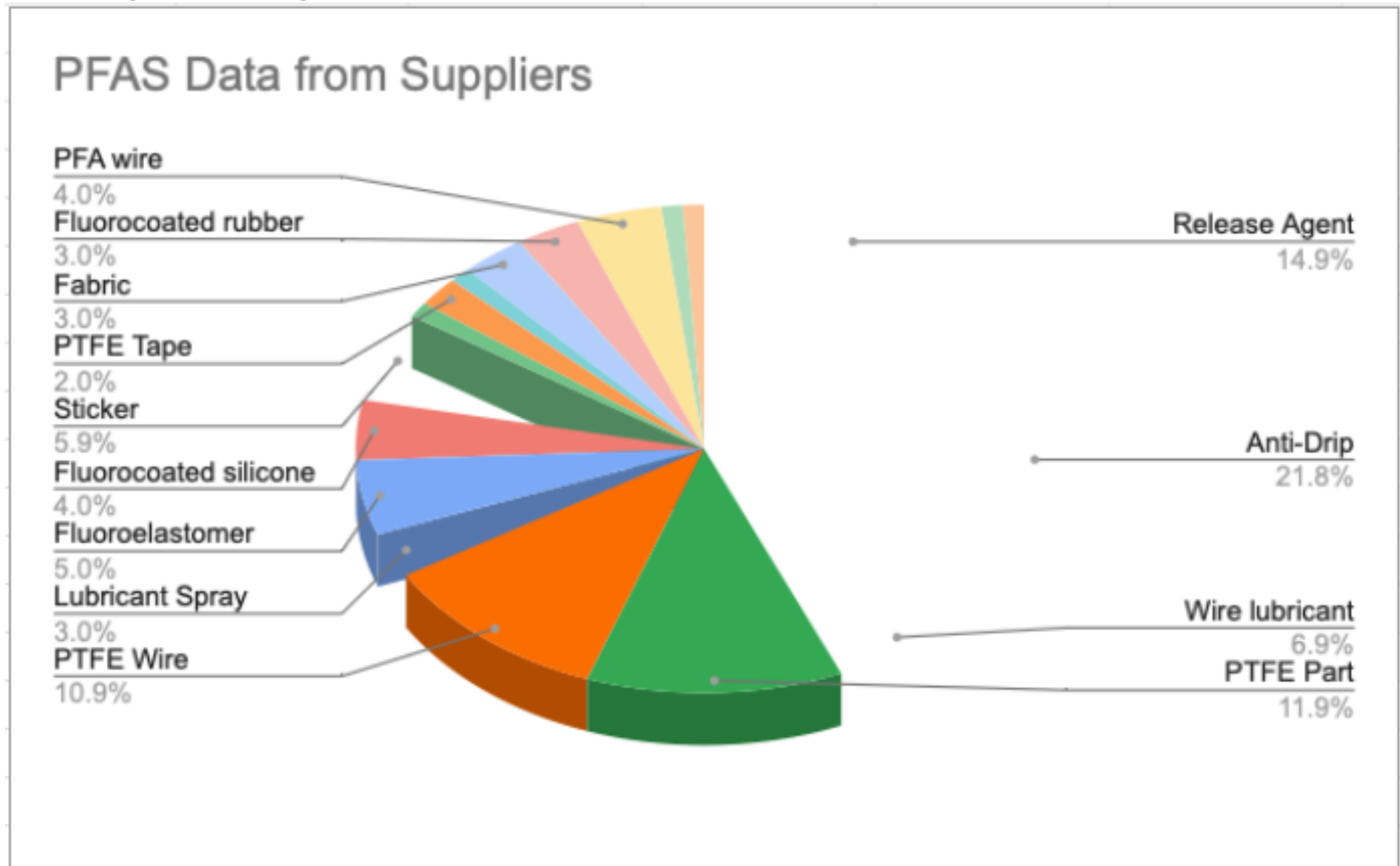
If you used CIC instead of WD-XRF

- 30% of PFAS instances would be missed with CIC



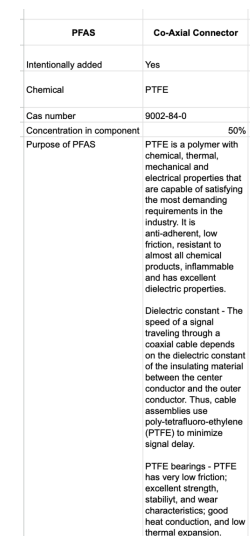
From Supplier Data Gathering

- ~50% of PFAS instances are being missed by supplier data gathering



Other common PFAS components

- Components that were either
 - Non-statistically significant, or
 - Not testable (for safety reasons)
- Fluoropolymer binder in lithium batteries
- Fluoropolymer binder in super/ultra capacitors
- Paper or paperboard food contacting materials



Claigan EU PFAS Restriction Project

Tentative Schedule

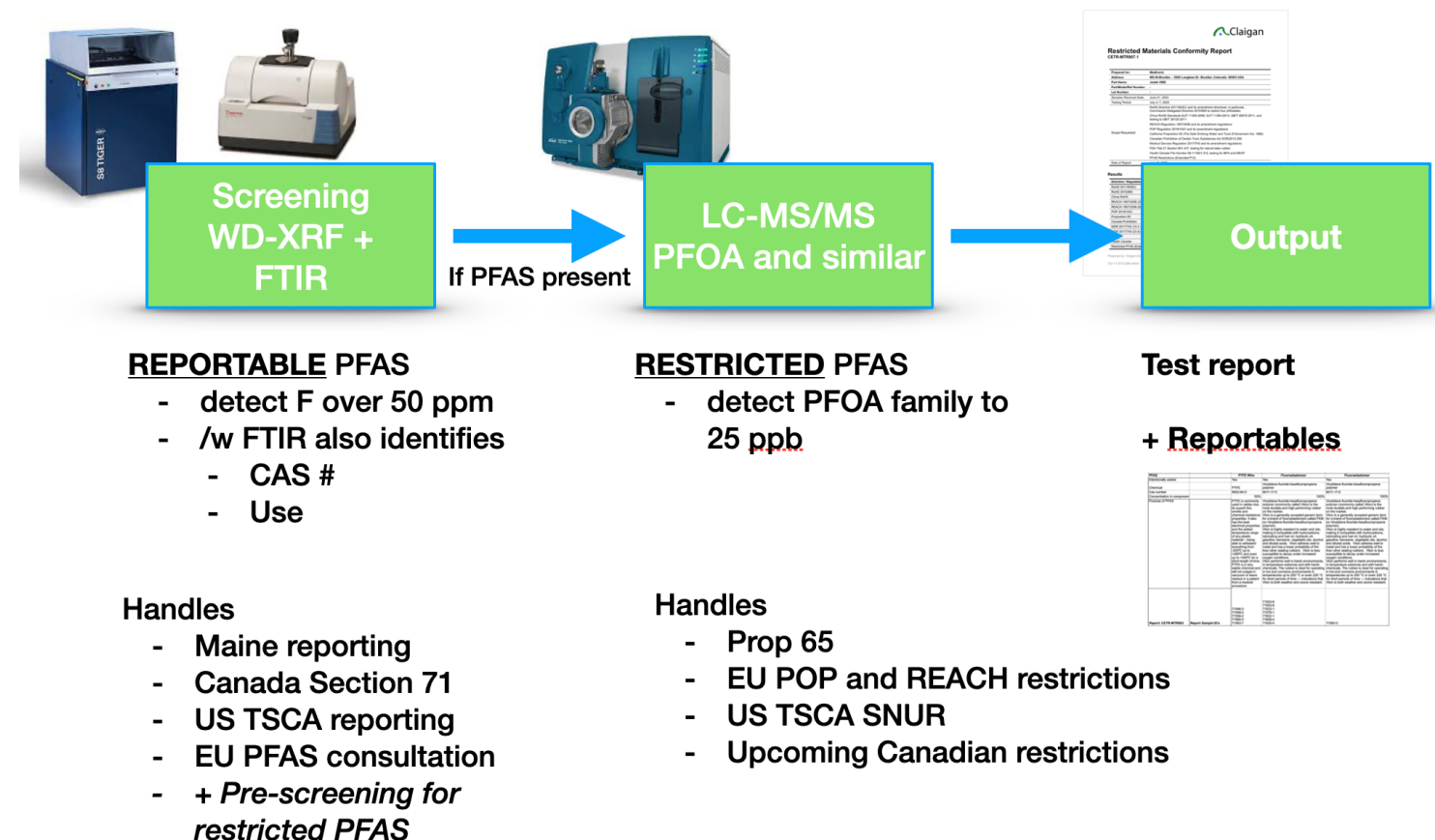
#	Milestone	Date	Complete
1.0	Customer Uses	Provided upon sign-up	Yes
2.0	Introduction Meeting	July 12 & 13 2023	Yes
3.0	Customer Uses Deadline	July 14 2023	Yes
4.0	Draft Derogations Meeting	August 2, 2023	Yes
5.0	Draft Technical Submissions and Update on Derogations	September 6 2023	
6.0	Final Derogations Submission Meeting	Mid September 2023	
7.0	EU PFAS Submission Deadline	September 25, 2023	

Claigan PFAS Testing

- **Q&A**

- Claigan PFAS testing

- Simple
- Accurate
- Comprehensive



- PFAS Submission Project

- **Strongly recommended**

