THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR

CONDUCTIVE • COLOR • FLAME RETARDANT

Flame Retardants and the Evolving Regulatory Landscape

Derek LaRock

Product Development Engineer

Flame Retardant Products

RTP Company Corporate Headquarters • 580 East Front Street • Winona, Minnesota 55987 USA

website: www.rtpcompany.com • email: rtp@rtpcompany.com • Wiman Corporation • +1 320-259-2554

TELEPHONE:

U.S.A.	SOUTH AMERICA	MEXICO	EUROPE	SINGAPORE	CHINA
+1 507-454-6900	+55 11 4193-8772	+52 81 8134-0403	+33 380-253-000	+65 6863-6580	+86 512-6283-8383

Overview

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Background/Overview**
- **Thermoplastic Flammability**
  - Flame Retardant Additive Chemistries and Mechanisms
- **Regulatory Landscape**
- **Testing Standards**
- **FR Products meet End Applications**

Flame Retardant (FR) Materials

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Definition

Materials that do not ignite readily or propagate flames under small to moderate fire exposures

- Materials are combustible
- Fire retardants reduce the intensity and spread of fire
- Reduces smoke and toxic by-products of combustion.

Fire Triangle

Goals of Flame Retardant Compounds

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Increase Resistance to Ignition
- Reduce Rate of Flame Spread
- Reduce Rate of Heat Release
- Reduce Smoke Emission

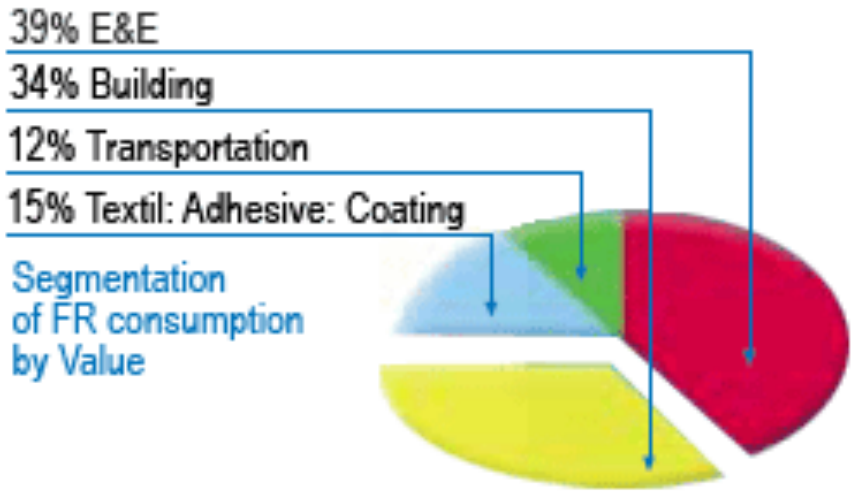
End Goal

- Meet FR Specifications
- Make the World a Safer Place!

Markets for FR Thermoplastics

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Electrical Parts
- Electronic Enclosures
- Wire and Cable
- Appliances
- Transportation
- Building and Construction



RTP Co.
Imagineering Plastics®

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR
CONDUCTIVE • COLOR • FLAME RETARDANT

Flammability of Thermoplastics

RTP Company Corporate Headquarters • 580 East Front Street • Winona, Minnesota 55987 USA
website: www.rtpcompany.com • email: rtp@rtpcompany.com • Wiman Corporation • +1 320-259-2554
TELEPHONE:

U.S.A.	SOUTH AMERICA	MEXICO	EUROPE	SINGAPORE	CHINA
+1 507-454-6900	+55 11 4193-8772	+52 81 8134-0403	+33 380-253-000	+65 6863-6580	+86 512-6283-8383

ISO 9001

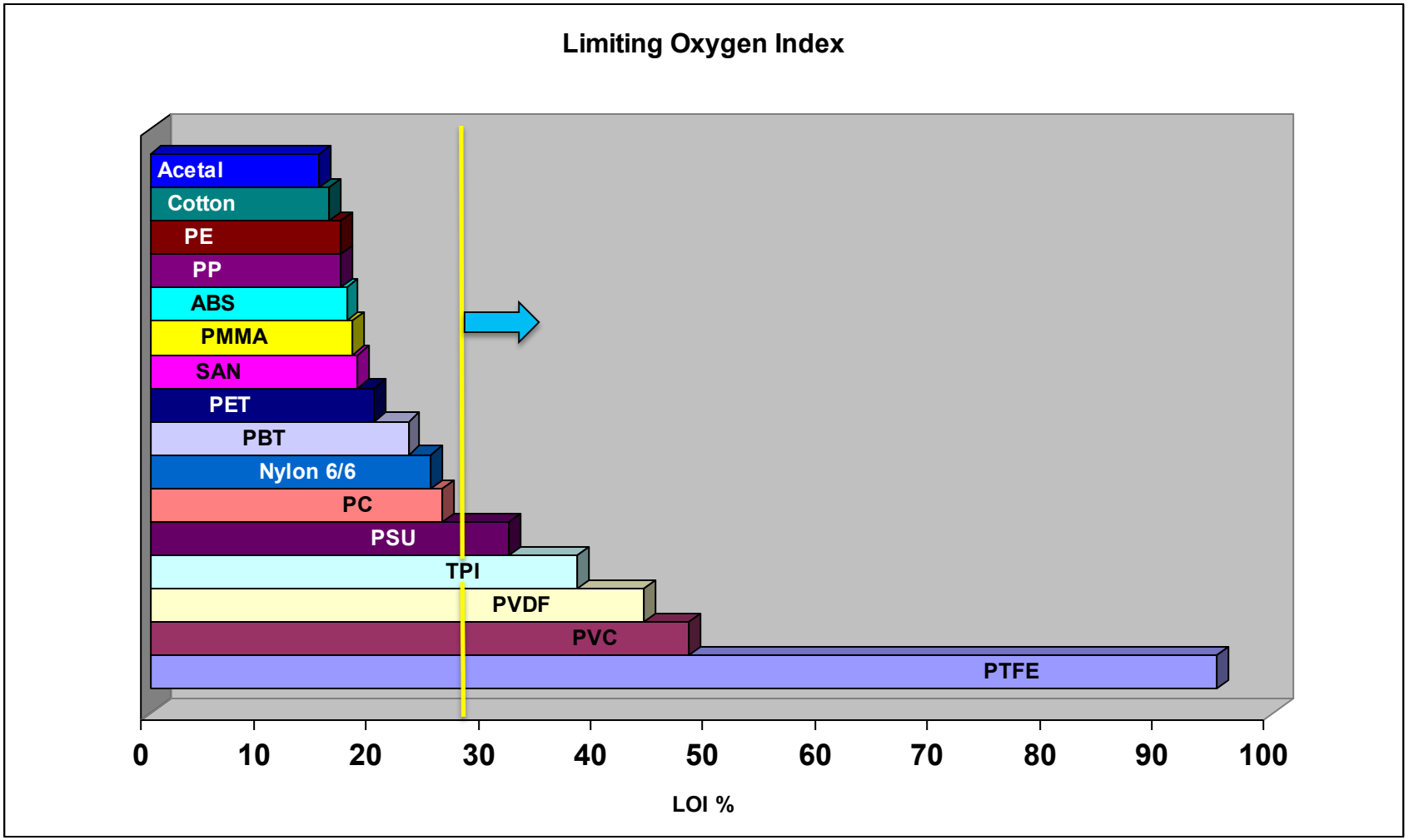
Thermoplastic Resin Flammability

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Flammable	Inherently Flame Resistant
• Polyolefins • Nylons • Polycarbonate • Polyesters • Styrenics • TPE'S	• Polysulfones • Polyphenylene Sulfide • Polyetheretherketone • Polyetherimide • Flouropolymers

Challenges of Flame Retarding Plastics

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



RTP Co.
Imagineering Plastics®

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR
CONDUCTIVE • COLOR • FLAME RETARDANT

Flame Retardant Additives and Mechanisms

RTP Company Corporate Headquarters • 580 East Front Street • Winona, Minnesota 55987 USA
website: www.rtpcompany.com • email: rtp@rtpcompany.com • Wiman Corporation • +1 320-259-2554
TELEPHONE:

U.S.A.	SOUTH AMERICA	MEXICO	EUROPE	SINGAPORE	CHINA
+1 507-454-6900	+55 11 4193-8772	+52 81 8134-0403	+33 380-253-000	+65 6863-6580	+86 512-6283-8383

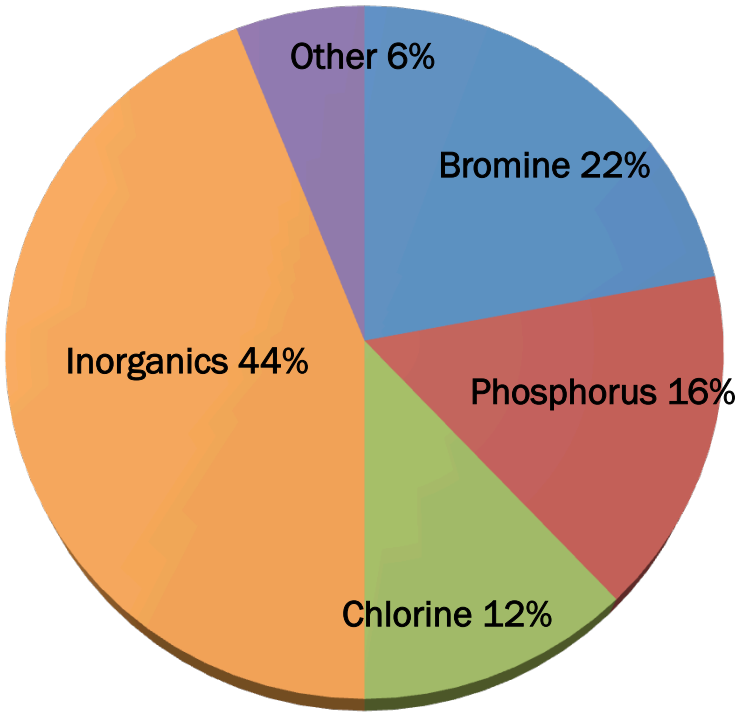
ISO 9001

Common Types of FR Additives

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Halogenated FR's**
  - Brominated
  - Chlorinated
- **Halogen Free FR's**
  - Metal hydroxides
  - Phosphorous Based
  - Melamine Based

Flame Retardant Additive Usage, 2011



Halogenated FR Mechanism

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- Halogenated technology inhibits the chemical reaction in the gas/vapor phase
- Various molecules that efficiently get large amounts of free radicals to the gas phase

Additive Type	Polymeric Type
• Higher Halogen Content • Lower Loadings • High Thermal Stability	• Melt Blendable • Less effect on physical properties • Enhanced Flow

Halogenated flame retardants are compatible in most resin systems with the exception of Acetal

Non Halogen Mechanisms

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Phosphorous

- Various forms
- Contributes to the condensed phase char formation

Hydrated Minerals

- Produce water during combustion process, dilute flammable vapors
- Insulative char formation

Melamine Cyanurate

- Endothermic decomposition
- Physical removal of flame from surface

Resin Systems

Polyolefins, Polyamides, Polyesters, Polycarbonate and alloys	Polyolefins, Polyamides	Polyamides, used as a synergist for other Phosphorous technologies

Halogen vs. Halogen Free

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Past

Halogenated

- Lower Cost
- Better Processing
- Better Efficiency
- Better Physical Properties

Halogen Free

- Limited Availability
- Low Smoke
- Lower Toxicity
- Less Corrosive
- Lower Specific Gravity
- Niche Product

Halogen vs. Halogen Free

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Past

Halogenated

- Lower Cost
- Better Processing
- Better Efficiency
- Better Physical Properties

Halogen Free

- Limited availability
- Low Smoke
- Lower Toxicity
- Less Corrosive
- Lower Specific Gravity
- Niche Product

Present

Halogen Free

- Evolving Economics
- Improved Processability
- Wide Variety of Products
- Low Smoke
- Lower Toxicity
- Less Corrosive
- Lower Specific Gravity

Choosing a FR System

How do we decide which FR mechanism to use?

- Resins System
- FR Specification
- Part Function
- Fillers/Additives
- Regulatory Concerns
  - Halogen, RoHS, etc

RTP Co.
Imagineering Plastics®

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR
CONDUCTIVE • COLOR • FLAME RETARDANT

Regulatory Landscape

RTP Company Corporate Headquarters • 580 East Front Street • Winona, Minnesota 55987 USA
website: www.rtpcompany.com • email: rtp@rtpcompany.com • Wiman Corporation • +1 320-259-2554
TELEPHONE:

U.S.A.	SOUTH AMERICA	MEXICO	EUROPE	SINGAPORE	CHINA
+1 507-454-6900	+55 11 4193-8772	+52 81 8134-0403	+33 380-253-000	+65 6863-6580	+86 512-6283-8383

ISO 9001

RoHS Directive

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Restriction of Hazardous Substances (RoHS)**
  - EU Directive in effect as of July 2006
- **Banned Substances**
  - Lead (Pb)
  - Mercury (Hg)
  - Cadmium (Cd)
  - Hexavalent Chromium (CrVI)
  - Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE)
- **Flame Retardants and Pigments**

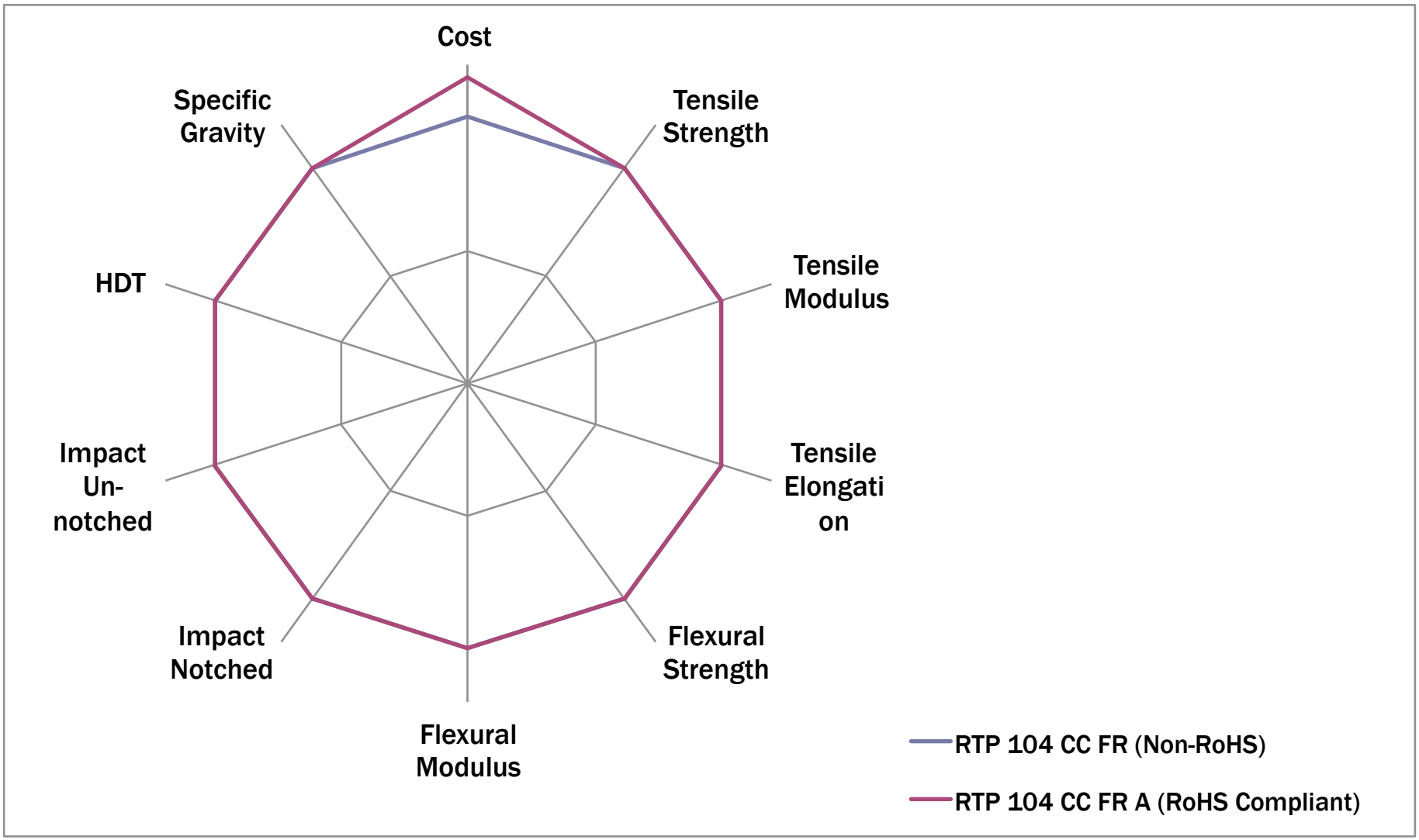
Does not need to be Halogen Free!

How does RoHS compliance affect material selection?

- **Drop in replacements available**
- **Identical Properties**
  - Physical, Flow, Heat Resistance, Processability
- **Cost Premium**

25% GF Polypropylene

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



Evolution of Halogen Free Technologies

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- More “self-policing”/customer driven bans
- New FR standards
- Green Movement
- More Effective FR Chemicals
- More Economical FR Chemicals
- Increased Performance
- Competition in the Market

Halogen Restrictions

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **OEM Driven Ban on Halogenated Chemicals**
  - HP, DELL, IBM etc.
- **Eco Labels**
  - Blue Angel, White Swan, Ecolabel etc.

Impact of Halogen Free

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Resin Limitations**
- **Physical Properties**
  - Strength/Impact
  - Flow
  - Heat Resistance
  - Resin Dependent
- **Flammability**
- **Cost**
- **Reduction in Specific Gravity**

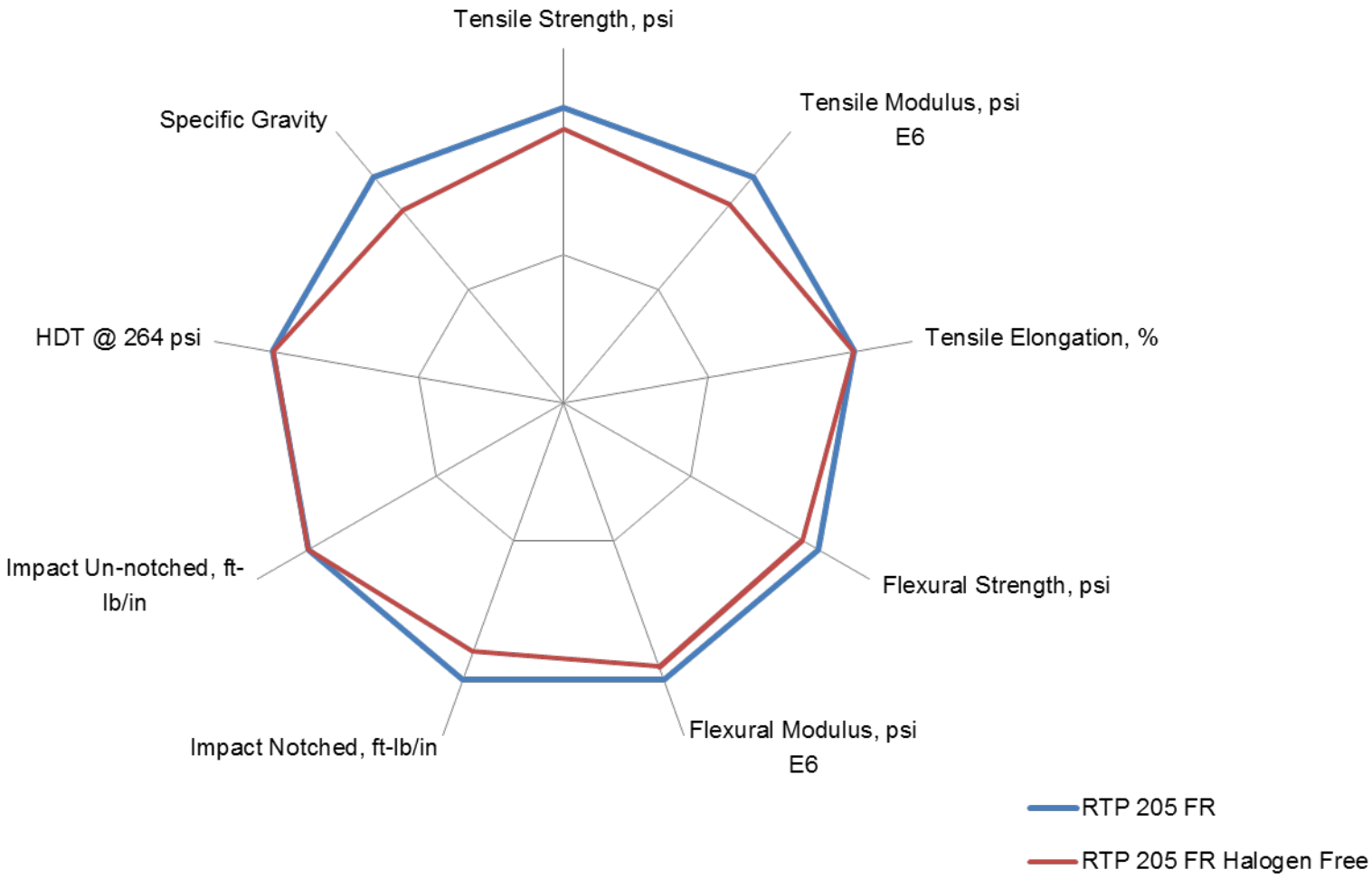
30% GF Nylon 6/6

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Mechanical Properties	RTP 205 FR	RTP 205 FR Halogen Free
Tensile Strength, psi	21000	19500
Tensile Modulus, psi E6	1.65	1.45
Tensile Elongation, %	2-4%	2-4%
Flexural Strength, psi	33000	31500
Flexural Modulus, psi E6	1.55	1.45
Impact Notched, ft-lb/in	2	1.8
Impact Un-notched, ft-lb/in	16	16
HDT @ 264 psi	470	470
Specific Gravity	1.66	1.41
Flammability	V-0 @ 1/32	V-0 @ 1/32

Property Comparison

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR

CONDUCTIVE • COLOR • FLAME RETARDANT

Test Standards

RTP Company Corporate Headquarters • 580 East Front Street • Winona, Minnesota 55987 USA
website: www.rtpcompany.com • email: rtp@rtpcompany.com • Wiman Corporation • +1 320-259-2554
TELEPHONE:

U.S.A.	SOUTH AMERICA	MEXICO	EUROPE	SINGAPORE	CHINA
+1 507-454-6900	+55 11 4193-8772	+52 81 8134-0403	+33 380-253-000	+65 6863-6580	+86 512-6283-8383

Electrical and Electronics (E&E)

- Appliance, Connectors, housings, etc.

- **UL 94**
  - V, 5V, HB
- **UL 746**
  - HAI, HWI, CTI

Lets look closer at…

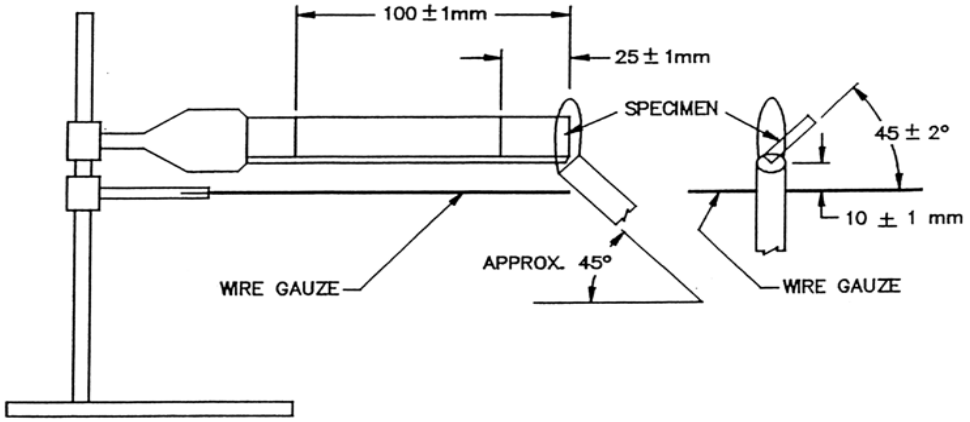
UL94

- Horizontal Burn (HB)
- Vertical Burn (V-0, V-1, V-2)

UL94 HB

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Horizontal burning test for HB classification



Classification Criterion

3.0 mm to 13.0 mm thickness

- *slower than 40 mm/minute or…*
- *combustion ceases prematurely*

< 3.0 mm thickness

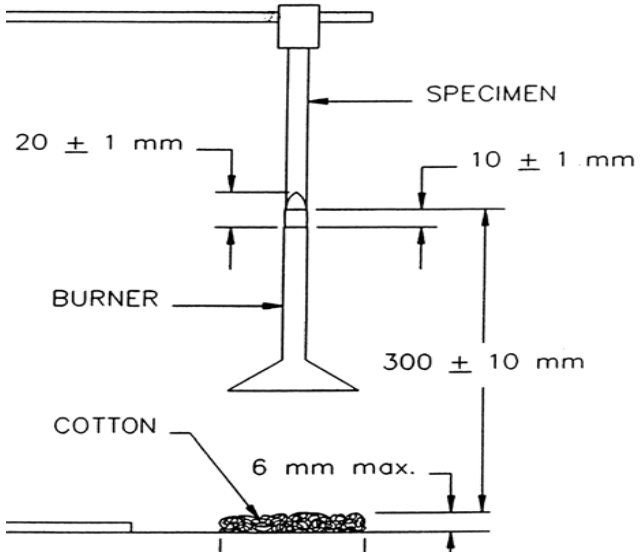
- *slower than 75 mm/minute or…*
- *combustion ceases prematurely*

*** In general most thermoplastics meet this criteria***

UL94 VB

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Classification Criteria	V-0	V-1	V-2
Number of bar specimens	5	5	5
Maximum flame time per specimen per flame application, sec	10	30	30
Maximum total flame time 5 specimens, 2 ignitions, sec	50	250	250
Specimen drips, ignites cotton	No	No	Yes
Maximum afterglow time per specimen, sec	30	60	60
Burn to holding clamp	NO	NO	NO

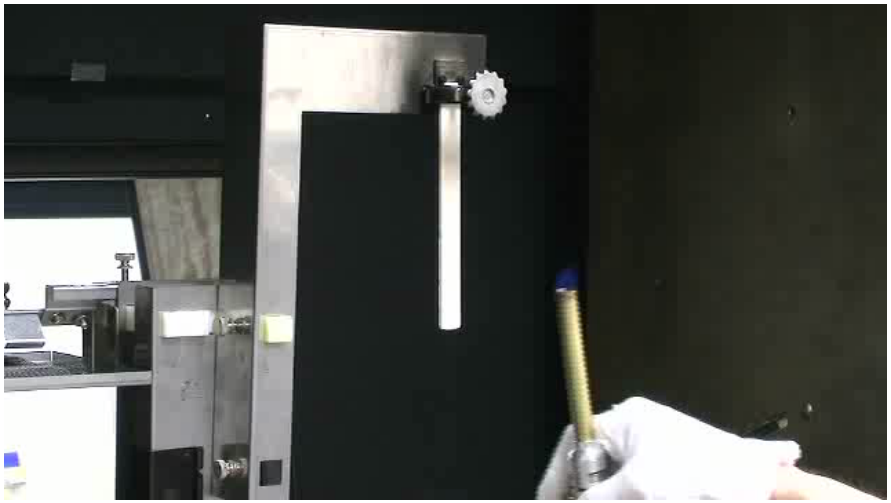


Thickness dependent ratings

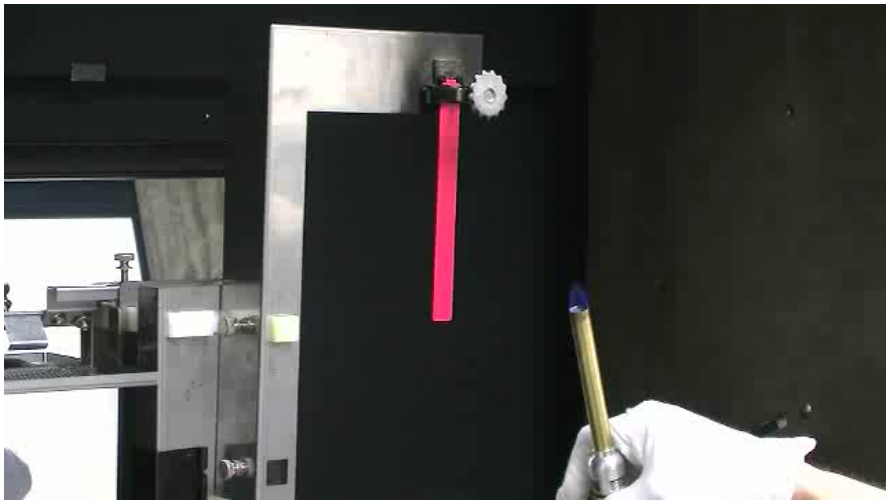
UL94 Vertical Burn Demo

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Flame Retardant – V-0



Non- Flame Retardant – No Rating



FAR 25.853

- **Flammability:**
  - 15-Second Horizontal Burn
  - 12-Second Vertical Burn
  - 60-Second Vertical Burn
- **Smoke Density:**
  - Ds@4min <200
  - ABD0031 or BSS 7238 or ASTM E-662
- **Ohio State University Heat Release:**
  - Calorimetry Test Measures Peak and Total Heat Release
  - <100/100, <65/65, & <55/55 are common

OEM Driven Requirements

- **Toxic Gas Emission:**
  - Varies by OEM
  - ABD0031 or BSS 7239

Requirements vary by part size and location

- **Requirements focus on:**
  - Low Smoke, Heat Release, Burn Rate, Flame Spread
- **Various standard that apply:**
  - UL2043, UL723/ASTM E84, ASTM E1354, NFPA 701, FM 4996, CAL TB133

- **Applications**
  - Wall coverings, Furniture, Plenum, Pallets, Storage systems, Roofing, Floor coverings, Ventilation

FR Products meet End Applications

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- LED Lens
- Outdoor Connector
- Overhead Speaker Unit
- Consumer Electronic Cover

FR Meets Transparency

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Market: Consumer

Application: LED Lens Cover

Problem: UL 94 V-0, High Light Transmission, UV, Light Diffusion, RoHS Compliance

Solution: PC – Transparent, Flame retardant, Specialty pigment package

Benefit: Provided ample diffusion of high powered LED lights with a proprietary pigment technology while achieving the required flame performance

FR Meets Outdoors /UV

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Market: Consumer

Application: Marine Connector

Problem: Strength/Impact, UV Resistance, Specialty color, UL94 V-0, F1

Solution: PC/PBT – Glass reinforced, UV stabilized, Flame retardant

Benefit: Product was able to pass the required drop impact testing and stringent UL outdoor and flammability ratings

FR Breaks Through the Ceiling

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Market: Industrial

Application: Speaker Unit

Problem: Plenum location, UL 2043, UL94 5VA, Rigidity

Solution: Polypropylene -- Glass fiber reinforced, Halogen free flame retardant

Benefit: Provided structural requirements needed for function and stringent UL flame resistance

FR Joins the Green Movement

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Market: E&E

Application: Wireless Access Point

Problem: Bio-Content requirements, Impact resistance, UL94 V-0, Green FR solution

Solution: PLA Alloy – Flame retardant, Impact modified

Benefit: Bio based material that meets demanding heat requirements, provides good dimensional stability and complies with the regulatory flame requirements

Designing for an FR application

- **Regulatory Landscape**
  - RoHS, Halogen Restrictions
- **Specifications**
  - UL94, FAR, ASTM, etc.
- **Part Function**
  - Performance Requirements, Application Environment, etc.
- **Economics**
  - Price is a Property

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR

CONDUCTIVE • COLOR • FLAME RETARDANT

Questions?

Derek LaRock

dlarock@rtpcompany.com

(507) 474-5413