

# MTG Shield

## Magnesium Melt Protection System

A Presentation for  
EPA SF<sub>6</sub> Conference 2006

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# Agenda

- Matheson Tri-Gas Company Overview
- Why Stop Using SF<sub>6</sub>?
- MTG Shield Overview
  - Active Ingredient
  - Process
  - Advantages
  - Successes
  - Economics
- Summary
- Q&A



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# Matheson Tri-Gas, Inc.

**Matheson Gas  
Products:  
Founded in 1927**

**Over 1000  
employees  
worldwide**

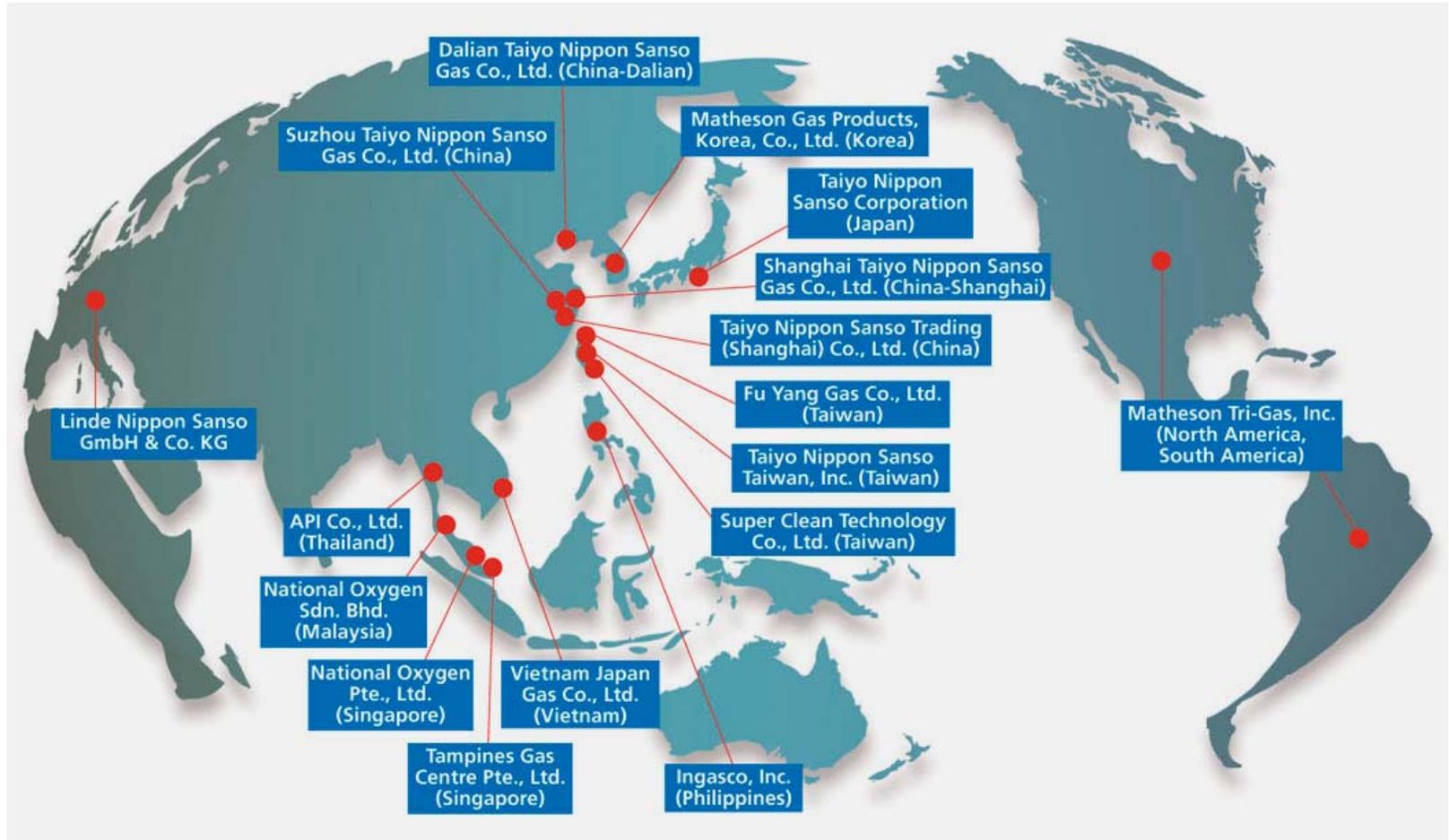
**Largest Subsidiary of  
Taiyo Nippon Sanso  
Corporation  
(the largest and most  
influential industrial gas  
company in Japan)**



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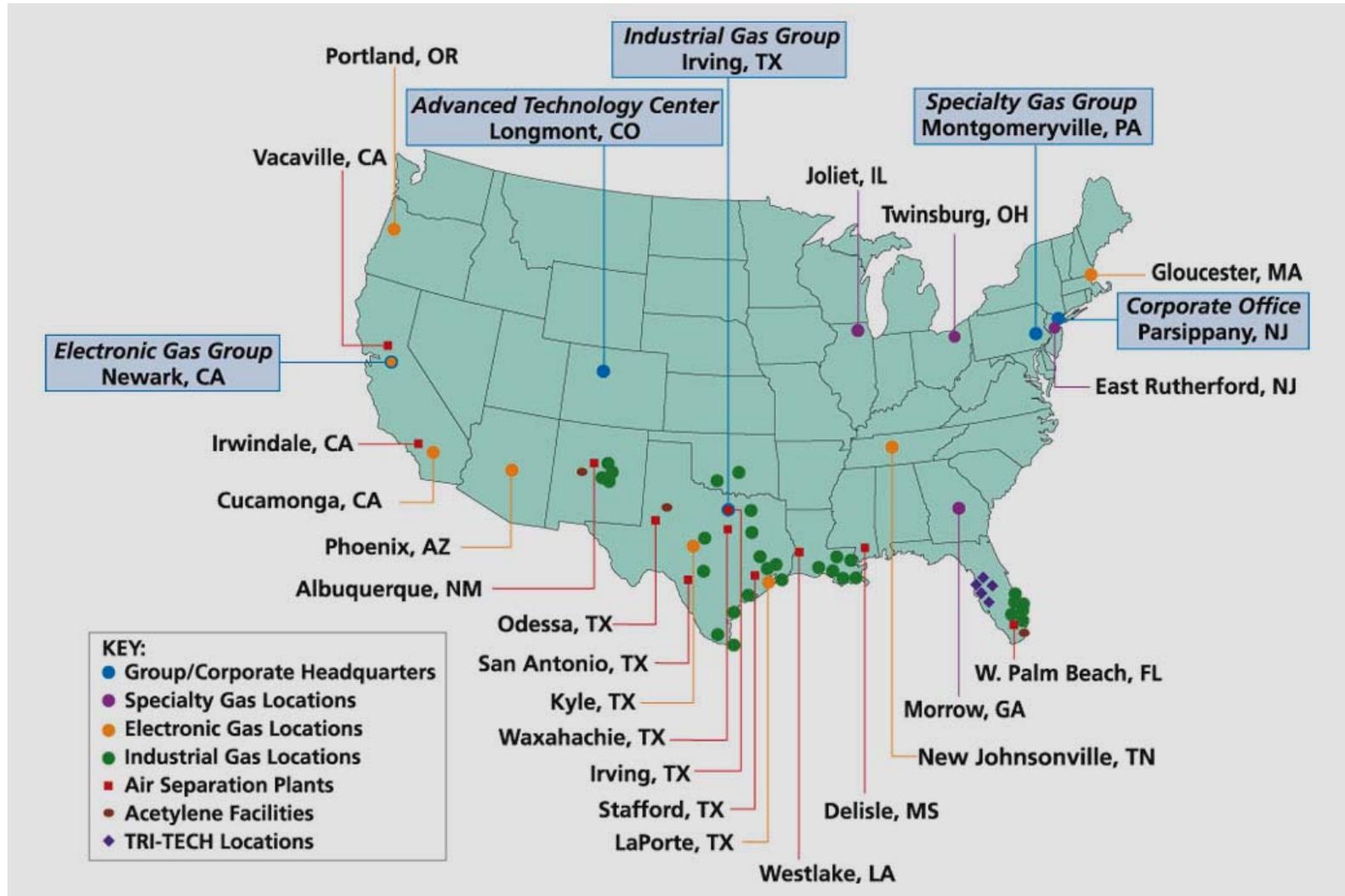
# Taiyo Nippon Sanso Corporation



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# Matheson Tri-Gas



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# Why Stop Using SF<sub>6</sub>?

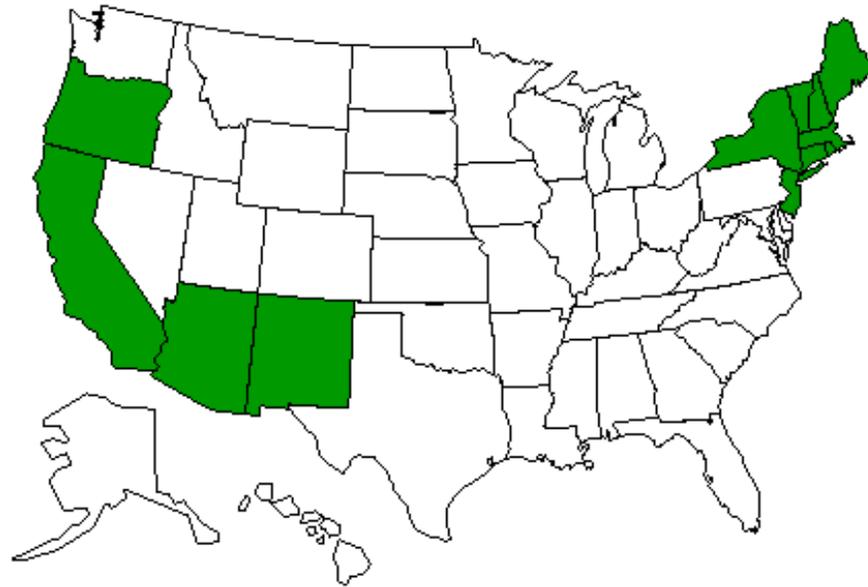
- International: Kyoto Treaty
- European Union: Discontinue SF<sub>6</sub> Use in Casting Industry by Year-End 2008
- Feb 2003 - EPA's Partners and the IMA Committed to Eliminate SF<sub>6</sub> Emissions by Year-End 2010



# Why Stop Using SF6?

## U.S. Greenhouse Gas Initiatives

- Currently 12 States have Greenhouse Gas Emissions Targets



- First U.S. Regulation to Put a Hold on Global Warming Gas Emissions
  - California Warming Solutions Act of 2006



# Why Stop Using SF6?

- Viable and Sustainable SF6 Replacement Technology Now Exists
- August 2006: Partnership Demonstrates New Technologies for the Magnesium Industry

“Led by the [SF6 Emission Reduction Partnership for the Magnesium Industry](#), a group of companies and researchers from Australia, Canada, Japan, and the U.S. conducted pilot tests and emission measurements for cutting-edge, climate-friendly melt protection technologies that promise significant environmental benefits.”

- <http://www.epa.gov/highgwp/magnesium-sf6/resources.html#media>



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# MTG Shield Overview

- Integrated Magnesium Melt Protection System
  - Patented in Japan
  - US & Europe Patent Pending
- MTG Shield Active Ingredient
  - Fluoroketone Liquid Mixture
  - 1.4% Novec 612 in Balance CO<sub>2</sub>
  - Supplied in Cylinders



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# MTG Shield Overview

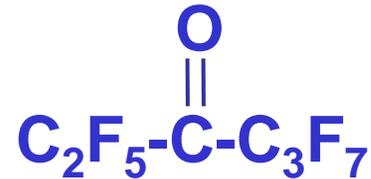
- MTG Shield Equipment
  - Cabinet which holds 2 Cylinders
  - Gas Mixing Panel (Required option)
  - Gas Distribution Panel (option)
  - Heated Regulator for CO<sub>2</sub> Supply (Required option for CO<sub>2</sub> Dilution)



# MTG Shield Active Ingredient Overview

- Physical Properties

- Fluorinated Ketone Liquid  
(3M's Novec™ 612)



- Vapor Pressure @20°C 32.6 kPa (~5 psia)

- Max. Gas Mix Concentration: 0.7% in 800 psi CO2

- Gas Density @80°C, 1 atm: 0.011 g/mL  
(Air is <0.001 g/ml)

- Nonflammable



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# Chemical Registry

- 3M's Novec™ 612 Internationally Registered
- U.S. EPA under TSCA
- ELINCS in Europe
- CDSL in Canada



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# MTG Shield Active Ingredient Overview

- Environmentally Friendly
  - Atmospheric Lifetime = 0.014 yrs (~ 5 days)
  - Low Global Warming Potential (GWP = 1 Same as CO<sub>2</sub>)
  - No Stratospheric Ozone Depletion Potential

<b>Environmental Properties</b>	<b>SF<sub>6</sub></b>	<b>SO<sub>2</sub></b>	<b>HFC-134a</b>	<b>Novec™ 612 Agent</b>
Atmospheric Lifetime (years)	3200	--	140	0.014
Global Warming Potential (GWP)	23,900	1	1300	1



# MTG Shield Active Ingredient Overview

- Safe to Use – Nontoxic at Room Temp
- Performance Comparable to SF<sub>6</sub> at a Much Lower Use Concentration
  - Concentration/Flowrate are 5 to 30% that of SF<sub>6</sub>
  - More Reactive than SF<sub>6</sub>
- Minimal (Manageable) Thermal Decomposition Products
- Sustainability
  - Viable and NOT Currently Subject to any Foreseeable Regulatory Actions



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# MTG Shield Process Overview

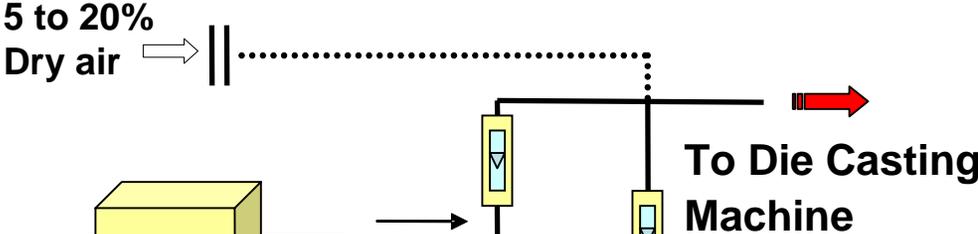
- Gas Supply Cabinet
  - Heats MTG Shield Cylinders to Supercritical State
  - Output is Concentrated MTG Shield Gas Mixture
- Concentrated MTG Shield Gas Mixture is Diluted to Final Working Concentration with Carrier Gas
- Preferred Carrier Gas
  - CO<sub>2</sub> with up to 20% Dry Air
  - Diecaster Furnaces Require O<sub>2</sub>



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# MTG Shield Process Overview



**MTG Shield  
Cylinder Cabinet**

**Carbon  
Dioxide for  
diluting**



# MTG Shield Cover Gas Distribution

- Performance Factors
  - Alloy Being Cast
  - Type of Casting Process
  - Furnace Heating Geometry
  - Ingot Addition Point
  - Operating Procedures Including Dross/Sludge Removal Methods and Frequency
  - Cover Gas Distribution and Flow Control



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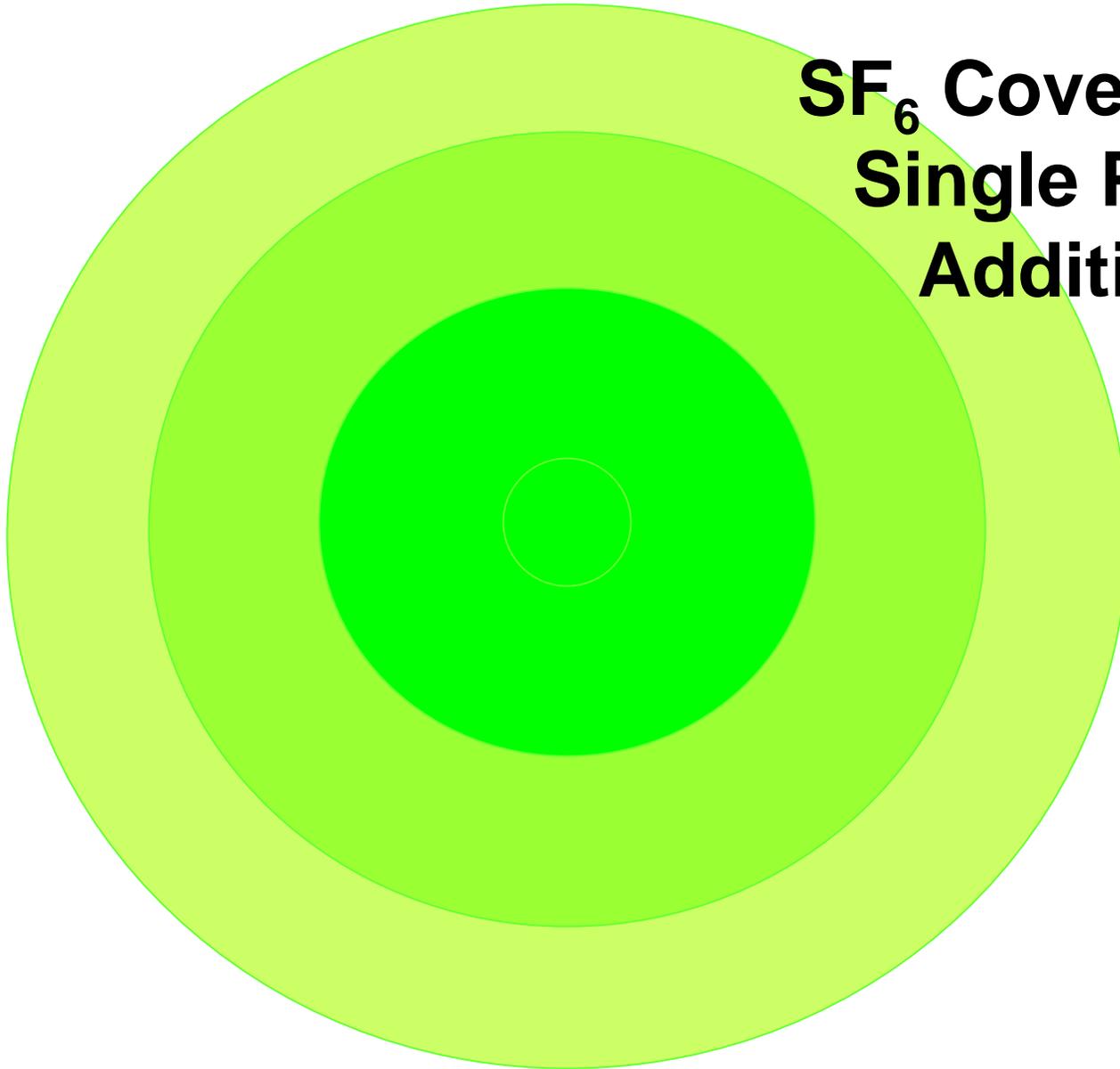
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# MTG Shield Cover Gas Distribution

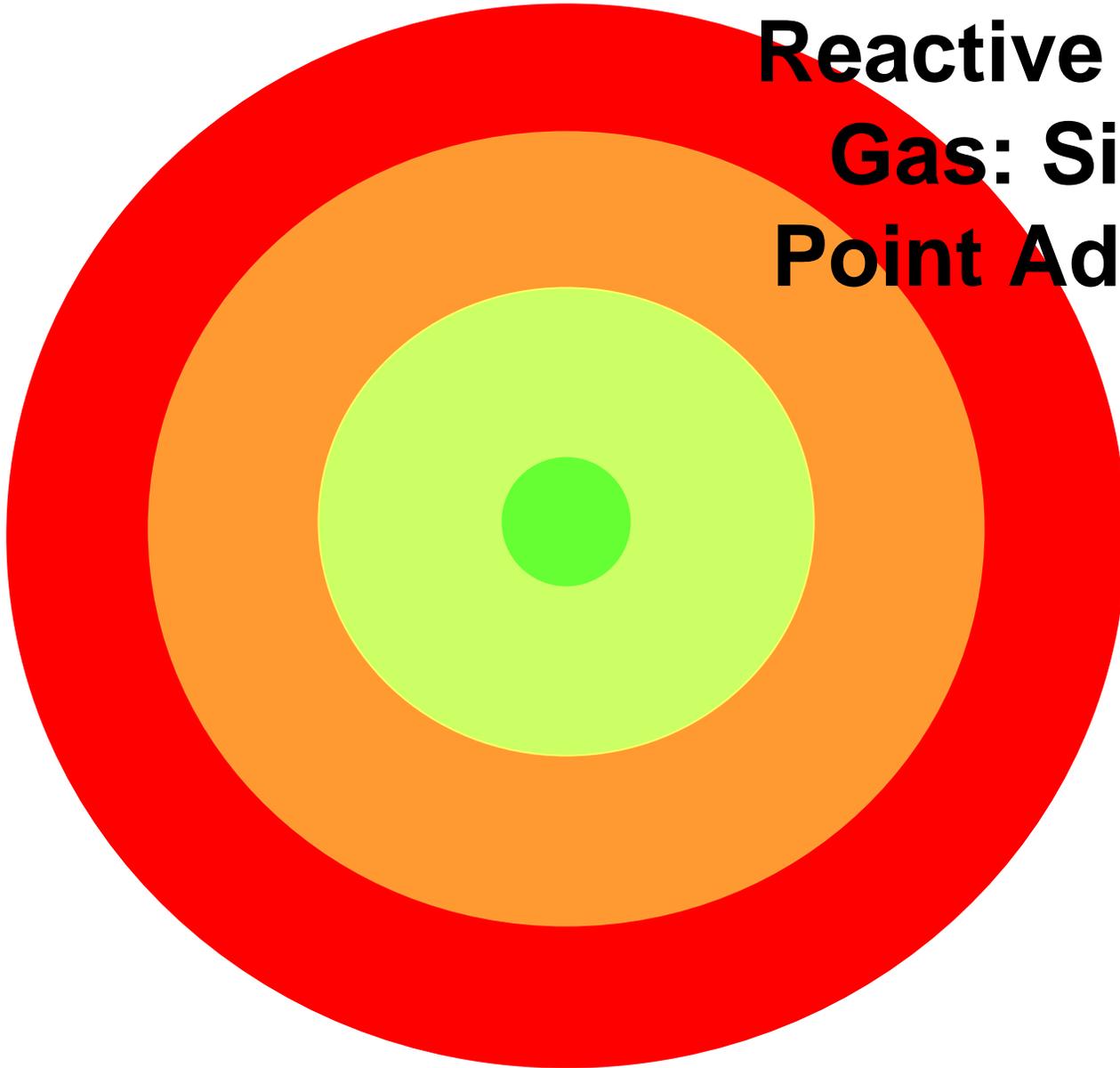
- MTG Shield Cover Gas is Denser Than SF<sub>6</sub>
  - More Limited Carry Than SF<sub>6</sub>
- **Even** Distribution of Cover Gas is Very Important For All SF<sub>6</sub> Substitutes
  - Much More Reactive
- **Uneven** Distribution Requires Higher Concentration and Higher Flow Rates
  - Higher Emissions of HF, Carbonyl Fluoride and Trace PFCs



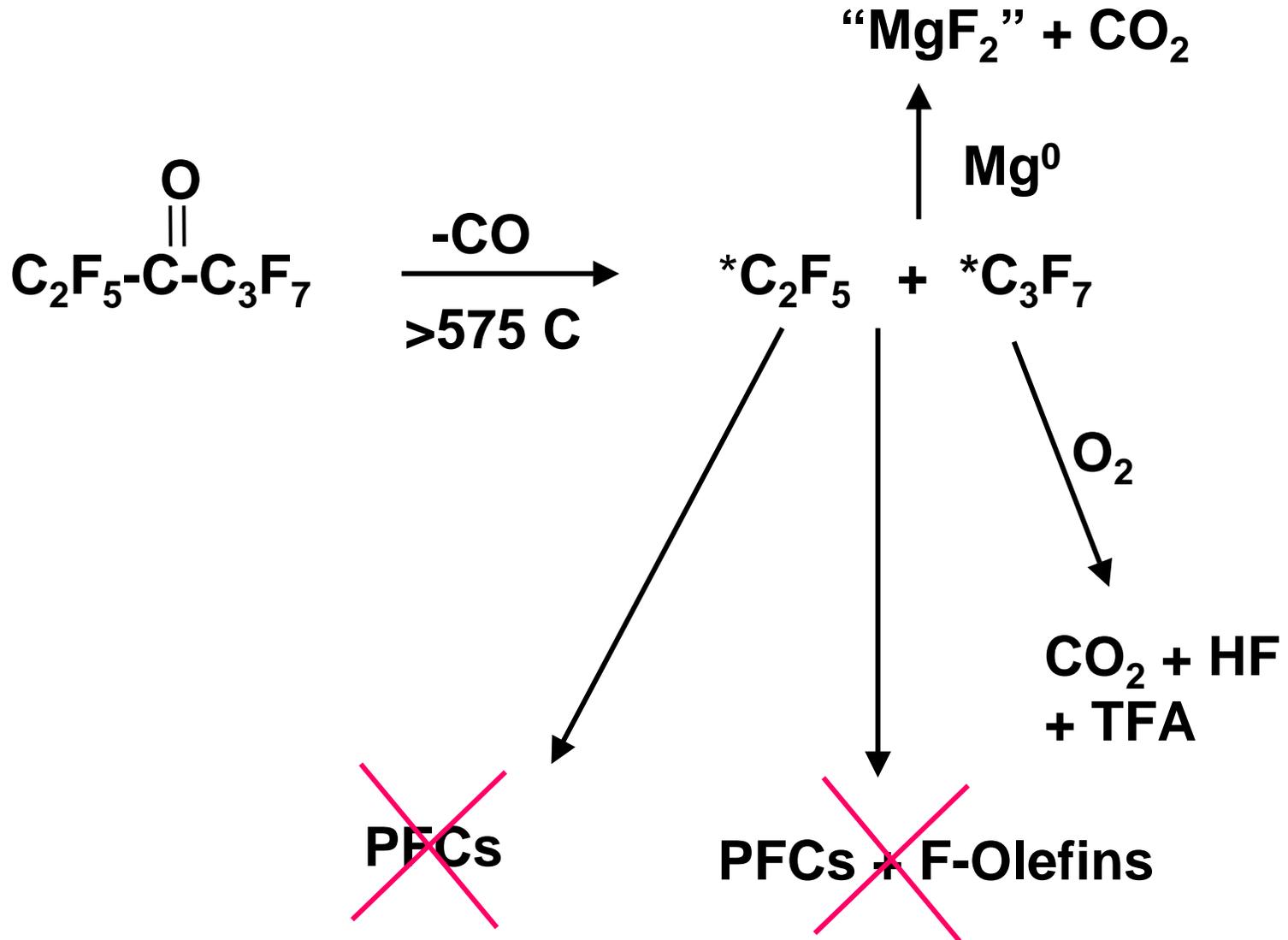
**SF<sub>6</sub> Cover Gas:  
Single Point  
Addition**



# Reactive Cover Gas: Single Point Addition

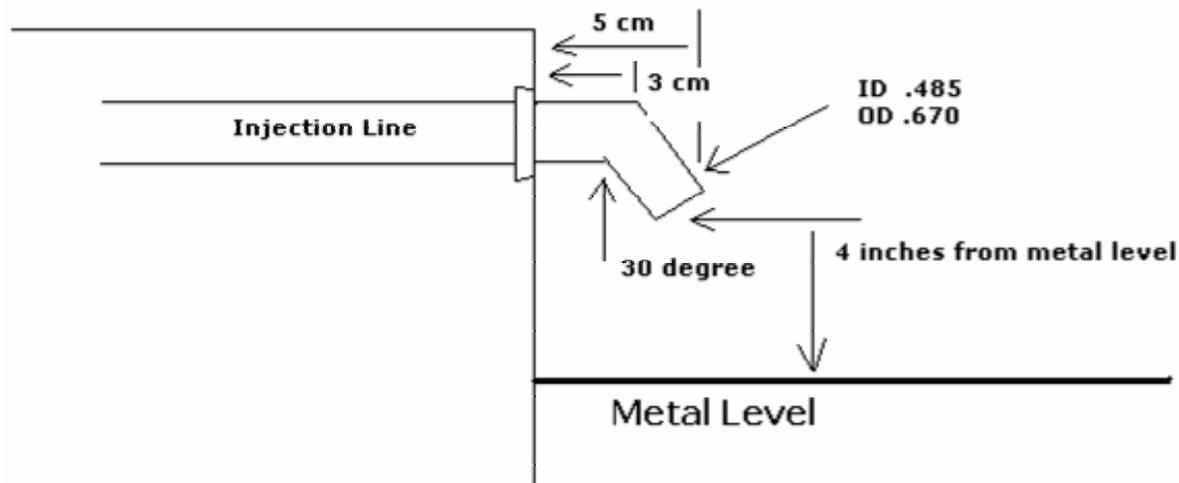


# Reactions of Novec™ 612

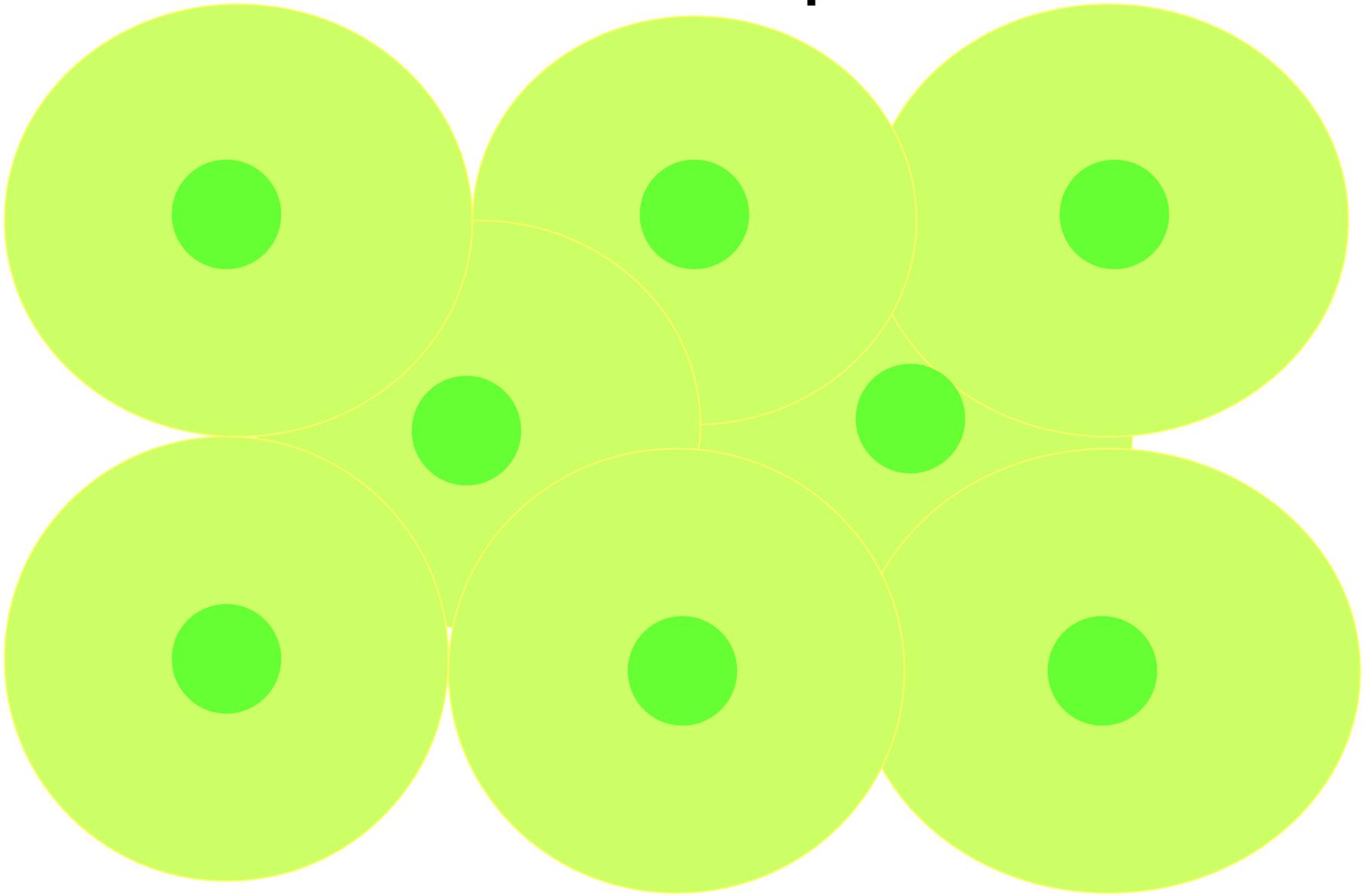


# Cover Gas Distribution

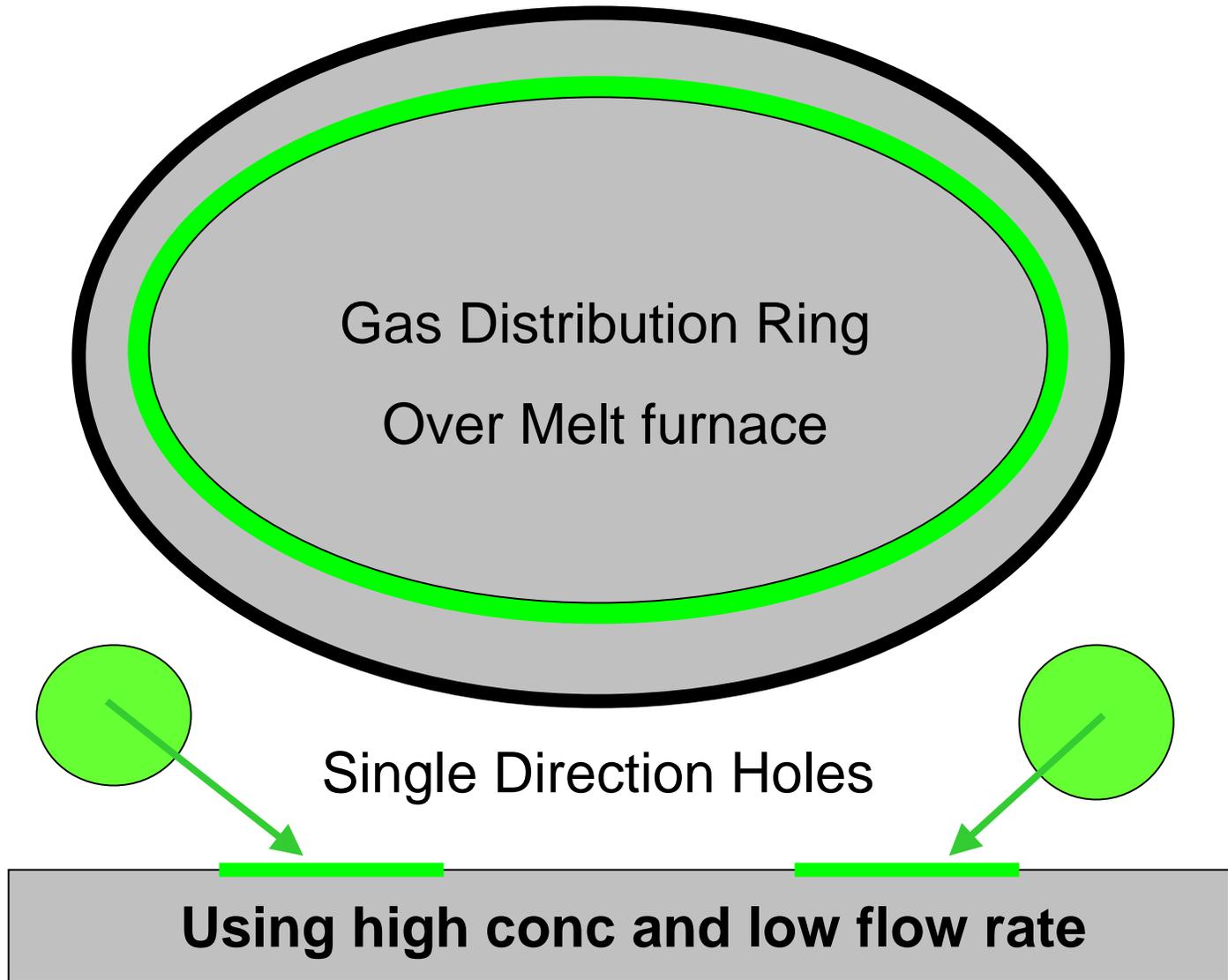
- In Furnaces, Multiple Point Addition Preferred Over Single Point Addition
- Vertical Nozzles, Downward Flow Introduction Preferred



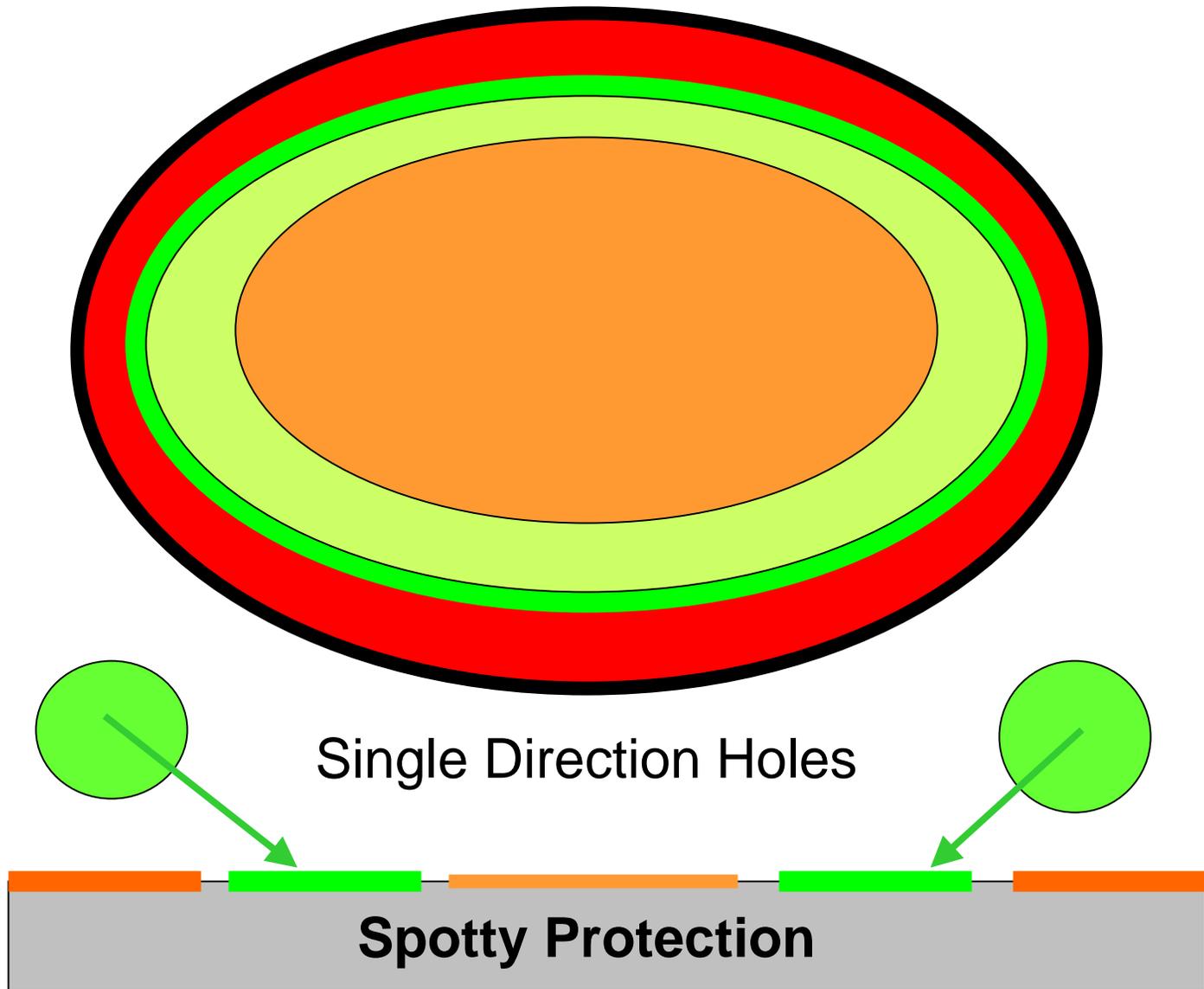
# Reactive Cover Gas: Multiple Point Addition



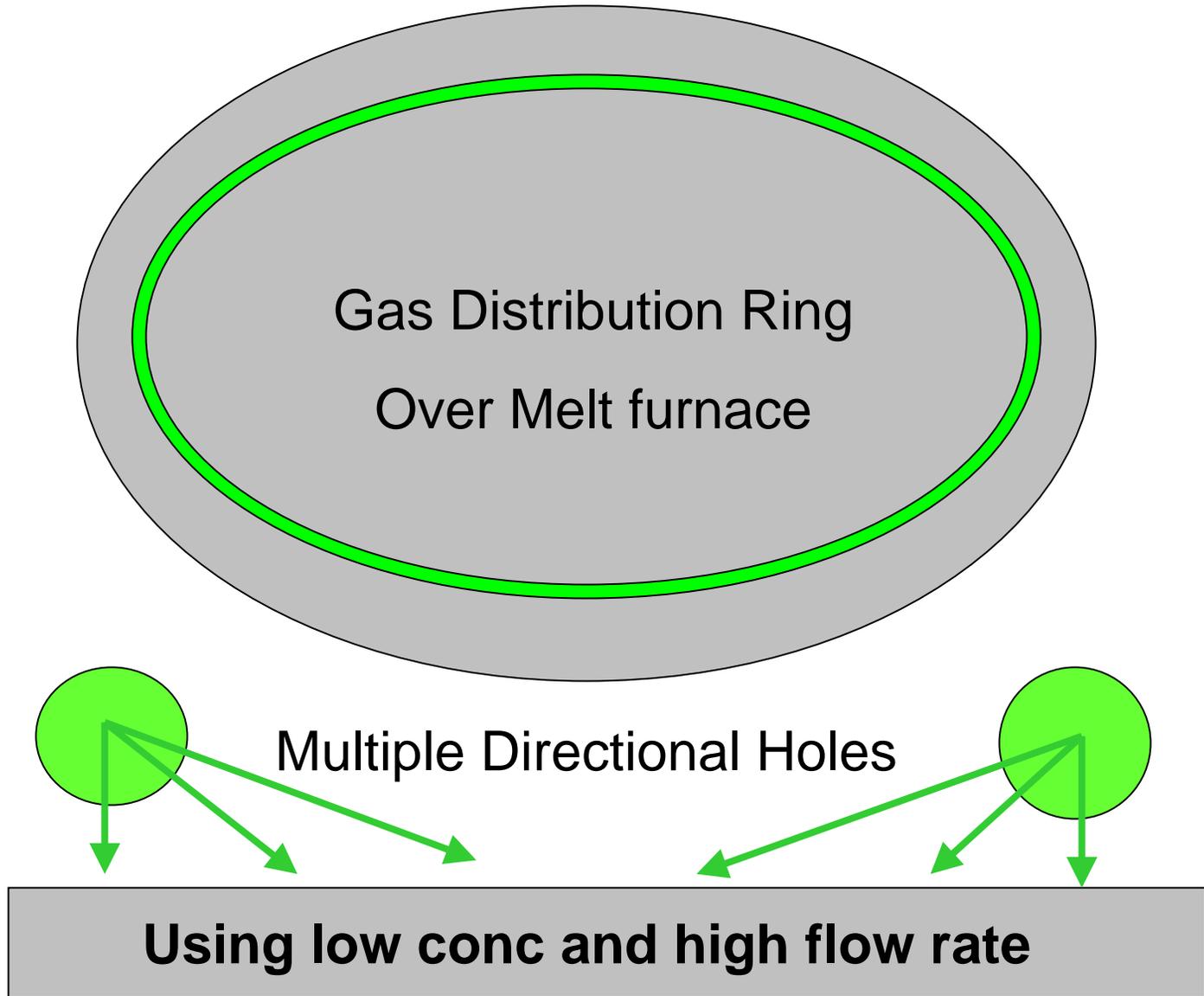
# Ring Cover Gas Distribution over a Melt Furnace



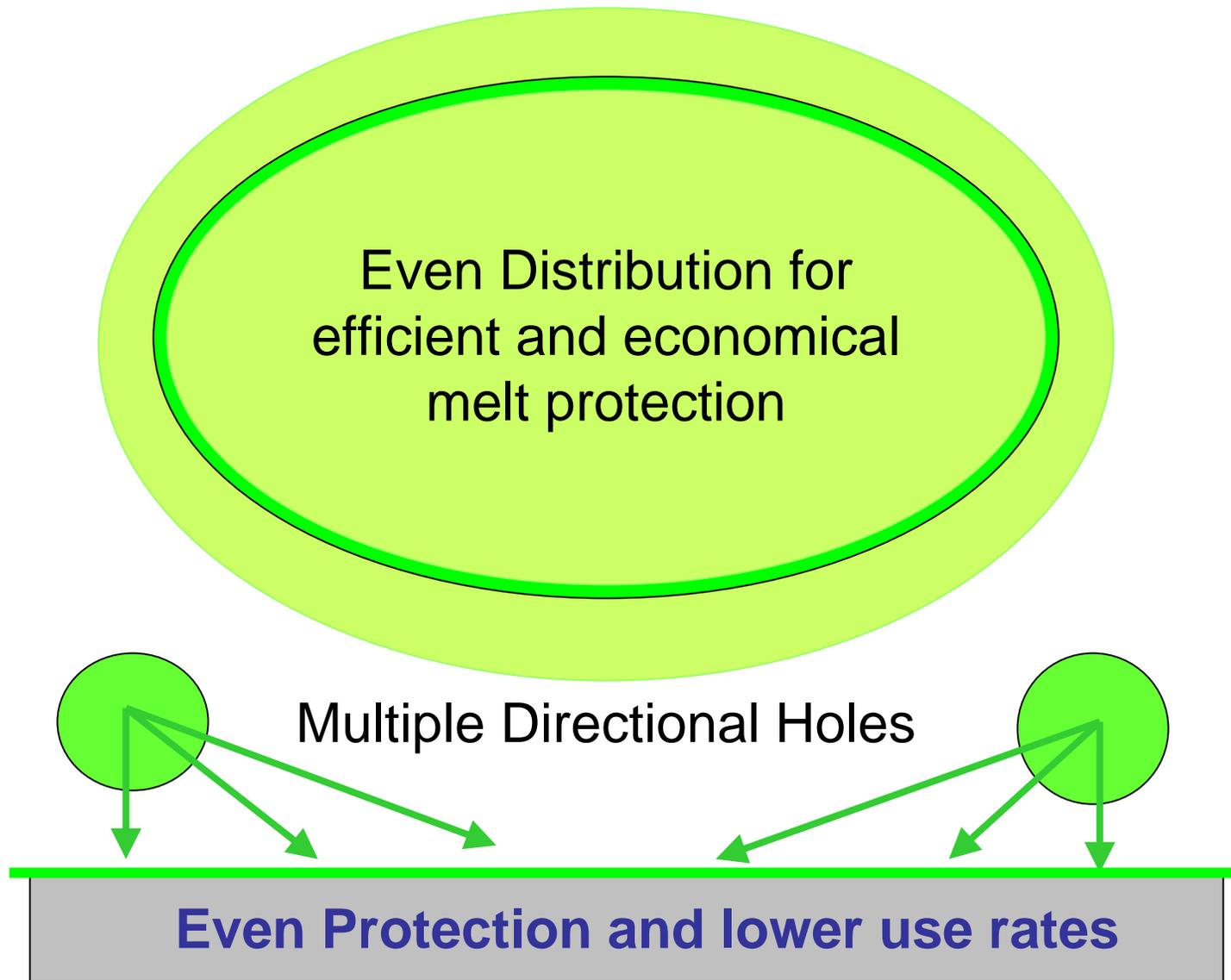
# Ring Cover Gas Distribution over a Melt Furnace



# Ring Cover Gas Distribution over a Melt Furnace



# Ring Cover Gas Distribution over a Melt Furnace



# MTG Shield Advantages

- Simple Supply Configuration Using a Proven Cover Gas Agent
- Cylinder Supply Makes it Easy to Control Cover Gas Concentration
  - Enables Constant Cover Gas Supply
  - Consistent Concentration
  - Precise Consumption
  - Less Chance of Generating Toxic and Corrosive gases
- Allows Continued Cover Gas Supply for a Period of Time in the Case of Power Failure

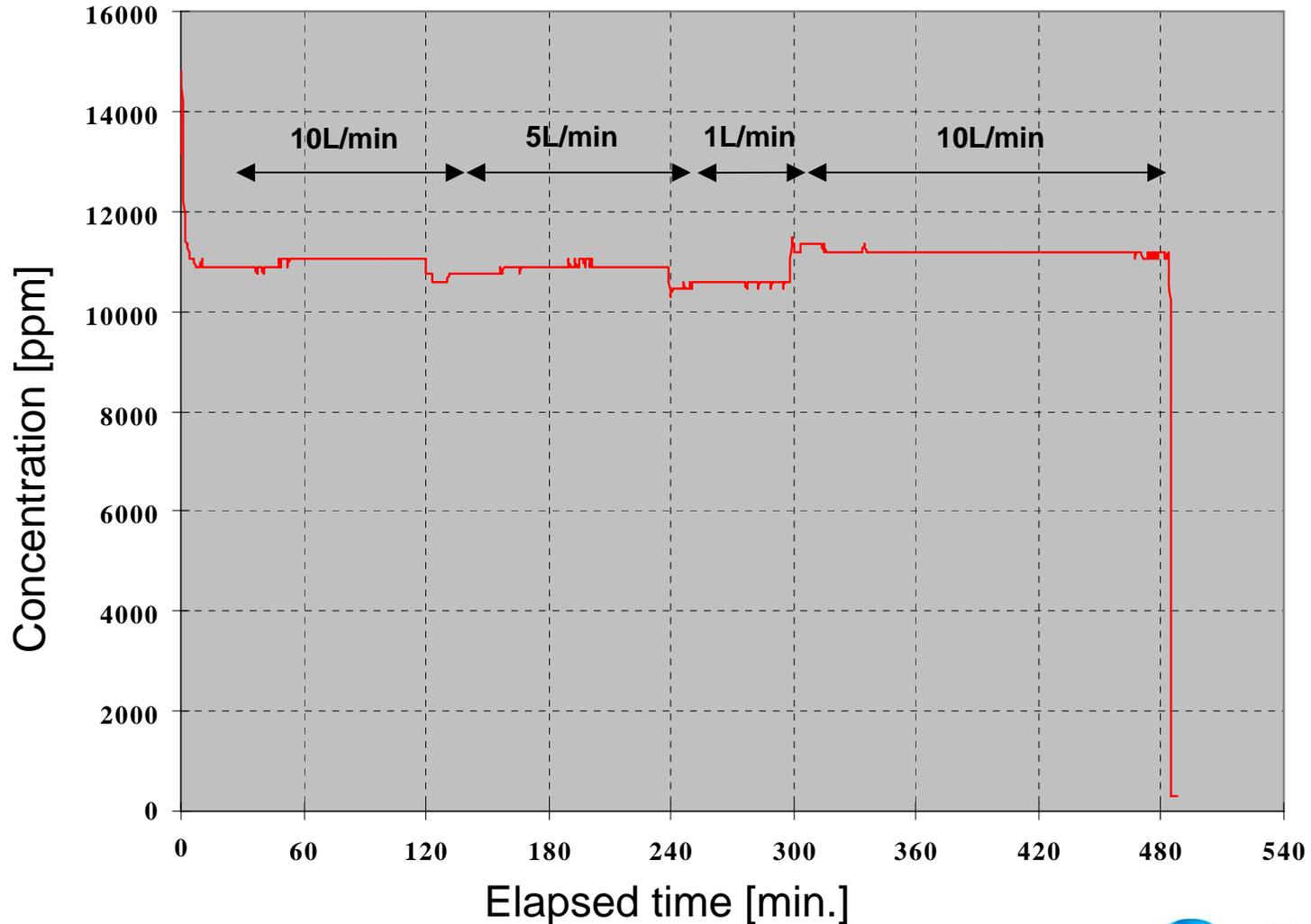


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# MTG Shield Consistency of Supply

Elapsed time change in concentration of Novec™ 612 (before dilution)



# MTG Shield Successes

- Tokai Rika, Otowa Plant, Japan Installation
- Several Additional Pilot Trials Completed and Currently Underway
- TNSC Presented with Japan Magnesium Association Technology Award for Mg Shield
- Successful EPA Die Casting Trial Conducted August 2006



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# US MTG Shield Die Casting Trial

- Conditions
  - Cold Chamber Die Casting
  - AZ91 Alloy
  - 0.3% SF6 Bal Air
  - 35 l/min flow rate
- MTG Shield Results
  - Excellent coverage at 150 ppm
  - Less than 50 ppm HF in the furnace



# US MTG Shield Die Casting Trial

(Uncorrected Trial Data: In-furnace Measurements)

Novec Conc In	400 ppm	200 ppm	~150 ppm
Going In Novec	343 ppm	190 ppm	152 ppm
Time:	8:50 a.m.	9:50 a.m.	3:25 p.m.
Furnace Concs:			
Novec ppm	178	86	28
HF ppm	128	177	48
COF2 ppm	0	0	0
H2O %	0.29	0.27	0.56
CO2 %	59.4	disc.	disc.
Oxygen	1%	1%	1%



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# Japan MTG Shield Sand Casting Trial

## Specification

Type	Sand Casting
Molten metal capacity	100 kg
Melting Temp	750
Casting Temp	750
Magnesium Material	ZE41A Mg 4% Zn 1% RE



Dissolution, refinement



Pouring from Melt Pot



Casting

## Cover Gas

<b>SF6</b>	<b>2.0% SF<sub>6</sub>, 10L/min, 100% CO<sub>2</sub></b>
<b>MG Shield</b>	<b>0.14% Novec 612, 20L/min, 100% CO<sub>2</sub></b>

# Lower Volume Application Options

- No Capital Option
- Pre-Mix: 1400 ppm Novec 612 balance CO<sub>2</sub>
- Dilution System Only Required
- Pre-Mix: 0.7% Novec 612 balance CO<sub>2</sub>



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# Cover Gas Economic Optimization

- Specific Magnesium Alloy
- Melt and Surface Temperature
- Exact Melt Furnace: Size and Configuration
- Furnace Lid and Cover Gas Ports
- Sealing at Lid, Doors and Ports
- Operating Procedures
- Carrier Gas Used ( $\text{CO}_2$  vs Air vs  $\text{CO}_2/\text{Air}$ )



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# MTG Shield Melt Protection System: Conclusions

- Virtually Eliminates GHG Emissions
- Commercially Proven and Viable
- Enables Tight, Stable and Consistent Supply of Cover Gas at Very Low Use Concentrations
- Optimized Conditions Result in Little to No HF and Byproduct Formation and More Economical and Efficient Operations



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# Questions?

## Thank You

**MTG Shield Contacts for More Information:**

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Sherry Everett: [sherryleverett@comcast.net](mailto:sherryleverett@comcast.net)



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