Montreal Protocol Destruction Requirements for HFC-23 and their Practical Implementation

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Presentation Scope

- Presentation has two parts
- Part 1: Montreal Protocol Destruction Requirements (applied HFC-23)
  - Why are destruction technologies approved by the MP?
  - Assessment/approval of destruction technologies by the MP
  - How are destruction technologies assessed and approved by the MP?
  - Importance of Destruction and Removal Efficiency (DRE)
  - Assessment of other pollutant releases for national/local governments
  - Destruction technologies approved by the Montreal Protocol
- Part 2: Operational/Regulatory Aspects of Destruction Implementation
  - Destruction facility specific qualification, licensing and performance monitoring
  - Upstream process/handling reduction of HFC-23 generation/emission
  - Tracking and accounting of destructed or converted HFC-23
  - Impacts associated with adoption of carbon monetization mechanisms
  - Accommodating circular conversion technologies in the MP framework

Part 1: Why are Destruction Technologies Approved by the Montreal Protocol?

- Generally founded on the principal that the MP recognizes and encourages environmentally sound destruction of end-of-life ODS/HFCs and now by-product HFC-23 to avoid emissions thus making a significant contribution to protection of the stratospheric ozone layer and/or global warming.
- The Montreal Protocol does not mandate mandatory the destruction of ODS or Annex F Group I HFCs except for situations where the amounts of controlled substances destroyed and accounted for within the Protocol's definition of 'production' under a Party's reporting obligations where the use of destruction technologies approved by MP is required.
- The exception is HFC-23 (Annex F, Group II) generated in manufacturing facilities for HCFCs and HFCs, from which emissions must be reported and destroyed to the extent practicable using technologies approved by the Montreal Protocol.

Approval of Destruction Technologies by the Montreal Protocol

- The MP has taken decisions to approve destruction technologies for the purposes of its production data reporting requirements and now for the general requirement to destroy HFC-23.
- The list of MP approved destruction technologies is updated over time based on the assessment of technologies and new technical information.
- As requested by the MP, this is undertaken by the Technology and Economic Assessment Panel (TEAP) who provide its technical assessment and recommendations under the direction of its Medical and Chemicals Technical Options Committee (MCTOC).
- TEAP has assessed destruction technologies in 1992, 1995, 2002, 2005, 2011, and 2018. Parties approve destruction technologies after considering TEAP's advice and recommendations.
- The most recent updated list of MP approved destruction technologies is included in Annex II to the 30th Meeting of the Parties where approved destruction technologies for HFC-23 were included. (Decision XXX/6)

When is it Mandatory or Optional to use MP approved destruction technologies?

- Mandatory Use of MP Approved Technologies
  - For end-of-life ODS/HFCs where the amounts are applied to a party's production reporting obligations.
  - By-product HFC-23 subject to emission (to the degree practical) from HCFC and HFC production
- Other than HFC-23, a party is free to use a destruction technology that meets minimum local regulatory standards and provides acceptable ODS/HFC destruction efficiencies.
- The MP approved technologies and associated performance criteria applied may serve as guidance in that technology selection, noting that more stringent performance standards may apply.
- As an example, MP approved technologies and destruction efficiency requirements may be used outside of the MP framework as a baseline requirement for voluntary carbon market transaction specifications.
- HFC-23 by-product destruction requires destruction using MP approved technologies for HCFC and HFC production.

How are destruction technologies assessed and approved by the Montreal Protocol?

- TEAP developed and uses technical performance criteria for its assessment.
- Criteria serve as a benchmark for comparison purposes and are not intended as standards for pollutant emissions, which are matters for governments and operators, nor do they necessarily meet internationally accepted emissions guidance for pollutants, such as those adopted by the Basel Convention.
- Destruction and Removal Efficiency (DRE) is a measure of the efficiency of destruction. DRE is calculated by subtracting the mass of a chemical released to air after destruction from the original amount of chemical fed into the system, as a percentage of the original amount.
- Costs (plant, maintenance, operation, cost per kg) and economic feasibility are not considered.

Destruction and Removal Efficiency is the key criterion for the Montreal Protocol

- In the preamble to the Montreal Protocol's decision XXX/6, where the approved technologies were last updated, the parties:
  - Noted that destruction and removal efficiency is the criterion considered in parties' approval of destruction technologies.
  - Suggested that parties also consider TEAP's other technical advice on emissions of substances other than controlled substances in the development and implementation of their domestic regulations.

TEAP Assessment and Advisory Criteria

- Basis of recommendation for approval is DRE, which is a minimum of 99.99% for concentrated sources (applies to HFC-23 by-product) and 95% for dilute sources (e.g., foams)
- Advisory Criteria – maximum advisory levels of emissions and minimum technical capability:
  - Halogenated dioxins and furans
  - Other pollutants: acid gases (HCl, HF, HBr/Br_2), particulate matter (total suspended particles), and carbon monoxide (CO)
  - Technical capability, where the technology has demonstrated destruction on at least a pilot scale or demonstration scale, and for which the processing capacity is no less than 1.0 kg/hr. of the substance to be destroyed, whether ODS/HFC or a suitable surrogate
- Qualification on HFC-23 generally serves as a surrogate for other HFCs, but not the reverse based on HFC-23's relatively higher thermal stability (i.e., considered harder to destroy)

TEAP Assessment and Advisory Criteria

Performance Qualification	Units	Concentrated Sources	Diluted Sources (e.g., foams)
DRE	%	99.99	95
Dioxins/furans	ng-ITEQ/Nm^3	0.2	0.5
HCl/Cl_2	mg/Nm^3	100	100
HF	mg/Nm^3	5	5
HBr/Br_2	mg/Nm^3	5	5
Particulates (TSP)	mg/Nm^3	50	50
CO	mg/Nm^3	100	100

MP Approved Destruction Technologies

- Approved destruction technologies are grouped into three categories:
  - Thermal oxidation
  - Plasma technologies
  - Conversion (non-incineration) technologies

- They are approved according to:
  - Technology type
  - Annex and Group of controlled substance
  - Concentrated sources or dilute sources

MP Approved Destruction Technologies -1

Technology	Concentrated				Dilute	
	Annex A	Annex C	Annex F			
	Group 1	Group 1	Group 1	Group 2		
	Primary CFCs	HCFCs	HFCs	HFC-23	ODS	HFCs
DRE*	99.99%	99.99%	99.99%	99.99%	95%	95%
Cement Kilns	Approved	Approved	Approved	Not determined		
Gaseous/Fume Oxidation	Approved	Approved	Approved	Approved		
Liquid Injection Incineration	Approved	Approved	Approved	Approved		
Municipal Solid Waste Incineration					Approved	Approved
Porous Thermal Reactor	Approved	Approved	Approved	Not determined		
Reactor Cracking	Approved	Approved	Approved	Approved		
Rotary Kiln Incineration	Approved	Approved	Approved	Approved	Approved	Approved
Argon Plasma Arc	Approved	Approved	Approved	Approved		

MP Approved Destruction Technologies - 2

Technology	Concentrated				Dilute	
	Annex A	Annex C	Annex F			
	Group 1	Group 1	Group 1	Group 2		
	Primary CFCs	HCFCs	HFCs	HFC-23	ODS	HFCs
DRE*	99.99%	99.99%	99.99%	99.99%	95%	95%
Inductively coupled radio frequency plasma	Approved	Approved	Not Determined	Not Determined		
Microwave Plasma	Approved	Approved	Not Determined	Not Determined		
Nitrogen Plasma Arc	Approved	Approved	Approved	Approved		
Portable Plasma Arc	Approved	Approved	Approved	Not Determined		
Chemical Reaction with H2 and CO2	Approved	Approved	Approved	Approved		
Gas Phase Catalytic De-halogenation	Approved	Approved	Approved	Not determined		
Superheated steam reactor	Approved	Approved	Approved	Approved		
Thermal Reaction with Methane	Approved	Approved	Not Determined	Not Determined		

TEAP/MCTOC Information Requirements for Destruction Technology Assessment

- Assessment process depends on having creditable technical performance information on destruction technologies for assessment.
- Generally sourced from Parties and proponent/operators
- Open invitation for submission of such information through the MP Secretariat
- Decision XXX/6 requests TEAP to assess destruction technologies, including any new technologies, and provide advice to parties. This will occur as part of MCTOC's 2022 Assessment Report.
- MCTOC has developed guidance on what information is sought to assess candidate destruction technologies which can be found in the 2021 TEAP Progress Report, Section 5.5.4 Page 76.
- Importance for new technologies particularly conversion technologies.
- Information is requested by January 2022 for assessment under decision XXX/6.

Part 2: Operational/Regulatory Aspects of Destruction Implementation -1

- Facility specific qualification
  - Destruction and environmental performance varies across approved technologies and within types of technology
  - Demonstration of performance, particularly destruction efficiency, should be required at facility licensing and is periodically verified, particularly for HFC-23
- Upstream process/handling reduction of HFC-23 generation/emission
  - Priority to optimize process to minimize HFC-23 by-product generation
  - Ensure and monitor process, piping and transfer integrity between point of generation and destruction including requirements for secure HFC-23 storage capacity requirements if destruction facility off-line

Part 2: Operational/Regulatory Aspects of Destruction Implementation - 2

- Tracking and accounting of destructed or converted HFC-23
  - Robust records and monitoring to verify destruction for purposes of compliance and potential revenue stream transactions
- Issues associated with adoption of carbon monetization mechanism
  - Balance benefits with potential to maximize HFC-23 generation/destruction for revenue generation
  - Additionality questions taking into account the lessons learnt from CDM projects and that HFC-23 destruction is required (with a practicality qualification) by the MP
- Accommodating circular conversion technologies in the MP framework
  - Feedstock versus waste as these are treated differently under the MP

Thank You for your Attention

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