

# 2006 IPCC Guidelines for Estimating SF<sub>6</sub> Emissions from Electrical Equipment and Other Products



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and the Environment

# Purpose of IPCC Guidelines

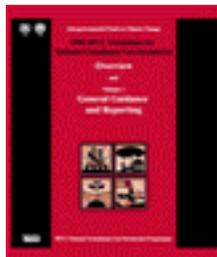
- United Nations Framework Convention on Climate Change (UNFCCC) requires countries to provide national inventories of greenhouse gas (GHG) emissions.
- IPCC Guidelines are used to estimate emissions
- The national significance of the source determines the choice of estimation accuracy and precision (Tiers).
- Earlier this year, the IPCC finished its two-year effort to update the Guidelines on estimating GHG emissions from all sources.

# Previous IPCC Guidance for “Industrial Sources,” Including EE

- 1996 IPCC Guidelines
- 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000 GPG)
  - Tier 1: Consumption = Emissions
  - Tier 2: Two emission-factor approaches
  - Tier 3: Three mass-balance approaches

# 2006 Guidelines: Five Volumes

1. General Guidance
2. Energy
3. Industrial Processes and Product Use
  - All SF<sub>6</sub> sources are here
4. Agriculture and Forestry
5. Waste



# SF<sub>6</sub> Sources in Vol. 3 of Guidelines

- Magnesium production: Chapter 4, Metal Industry Emissions
- Semiconductor and flat panel display production: Chapter 6, Electronics Industry Emissions
- Manufacture and use of electrical equipment: Chapter 8, Other Product Use
- Other sources (accelerators, military, etc.): Chapter 8, Other Product Use

# Revised Guidelines for Electrical Equipment Reflect Experience Since 2000

- 2006 GL both simpler and more flexible than their predecessor, the 2000 Good Practice Guidance
  - 3 methods rather than 6
  - GL's most advanced (Tier 3) approach allows combination of mass-balance and emission-factor methods to maximize accuracy and adaptability to national circumstances

# Two Types of Estimation Methods for Electrical Equipment

- Emission Factor (EF)

Emissions = EF x Bank (total charge)  
of SF<sub>6</sub> in equipment

- Mass-Balance (MB)

Emissions = Annual SF<sub>6</sub> consumption  
– SF<sub>6</sub> charge of new equipment  
+ SF<sub>6</sub> charge of retiring equipment

# EF vs. MB

- Both methods can be used at different levels of aggregation (lifecycle stage, facility, country) and accuracy
- Choice between methods depends on
  - Data availability
  - Country-specific circumstances
  - For most accurate approach, circumstances considered by life-cycle stage and equipment type (e.g., closed- vs. sealed-pressure)

# EF vs. MB

## **Mass-Balance more accurate where:**

- Emission rates vary across facilities and/or equipment, and to some extent, over time
- Process emission rates above 3%
- Equipment is refilled frequently
- Equipment stock is growing slowly
- Equipment containing SF<sub>6</sub> has been in use in the country for at least as long as the typical time between refills for that equipment.
  - 10-20 years for electrical equipment

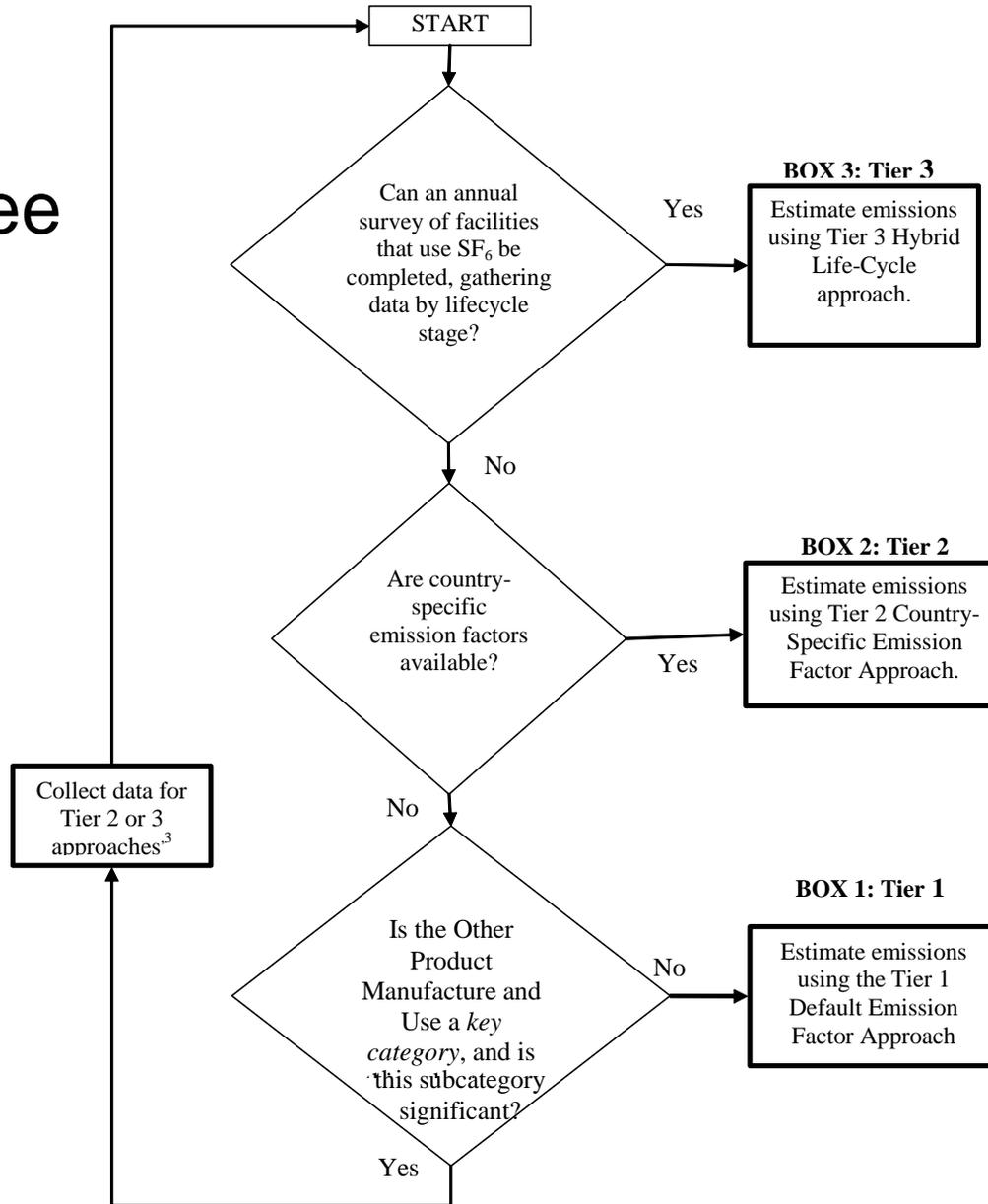
## **Emission-Factor more accurate where:**

- Emission rates are fairly constant within defined types of equipment and/or facilities
- Process emission rates below 3%
- Equipment is rarely or never refilled
- Equipment stock is growing quickly
- Equipment containing SF<sub>6</sub> has been in use in the country for less than the typical time between refills for that equipment.
  - 10-20 years for electrical equipment

# 2006 GL: Three Tiers

- Tier 1 (least complex, accurate): Default emission factors x SF<sub>6</sub> bank
- Tier 2 (middle): Country-specific emission factors x SF<sub>6</sub> bank.
- Tier 3 (most complex, accurate): Emissions estimated at each lifecycle stage at each facility using either EF or MB, as appropriate
  - U.S. EPS Partnership and German manufacturers and utilities use variants of Tier 3 approach.

# 2006 GL Decision Tree



## SF<sub>6</sub> Emissions Reduction Partnership for Electric Power Systems

# U.S. Approach

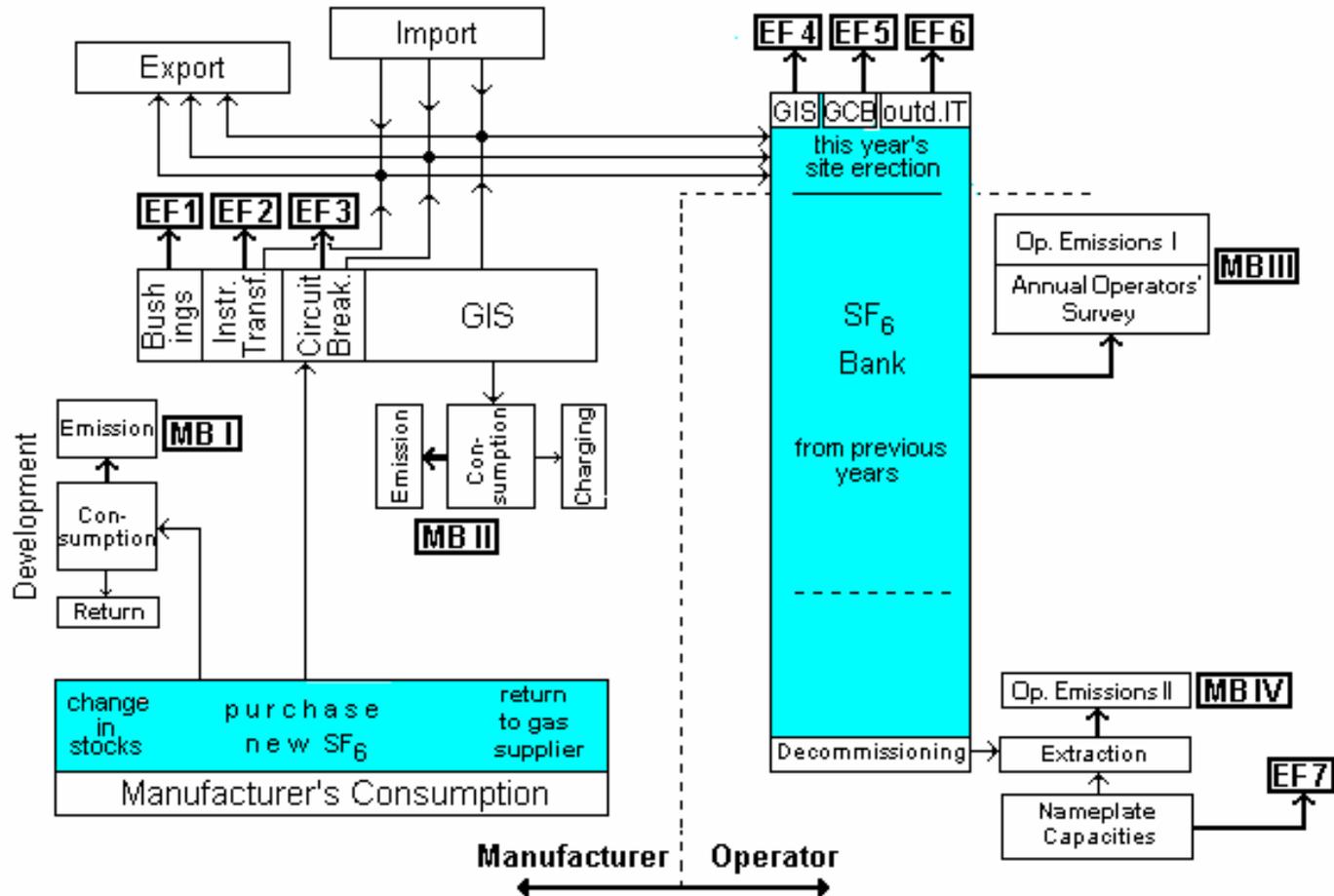
| <b>Annual Reporting Form</b>                    |  |  |
|---|--|--|
| Name: <input style="width: 95%;" type="text"/>  | Company Name: <input style="width: 95%;" type="text"/>   |  |
| Title: <input style="width: 95%;" type="text"/> | Report Year: <input style="width: 95%;" type="text"/>    |  |
| Phone: <input style="width: 95%;" type="text"/> | Date Completed: <input style="width: 95%;" type="text"/> |  |

| <b>CHANGE IN SF<sub>6</sub> INVENTORY (IN CYLINDERS)</b>                                     |               |  |
|--|---------------|--|
| Inventory (in cylinders, <b>not</b> equipment)   | AMOUNT        | Comments   |
| 1. Beginning of Year   |               |  |
| 2. End of Year   |               |  |
| <b>A. Change in Inventory (1 - 2)</b>  | -             |  |
| <b>PURCHASES/ACQUISITIONS OF SF<sub>6</sub></b>  |               |  |
|  | AMOUNT        | Comments   |
| 3. SF <sub>6</sub> purchased from producers or distributors in cylinders                     |               |  |
| 4. SF <sub>6</sub> provided by equipment manufacturers with/inside equipment                 |               |  |
| 5. SF <sub>6</sub> returned to the site after off-site recycling                             |               |  |
| <b>B. Total Purchases/Acquisitions (3+4+5)</b>   | -             |  |
| <b>SALES/DISBURSEMENTS OF SF<sub>6</sub></b>   |               |  |
|  | AMOUNT        | Comments   |
| 6. Sales of SF <sub>6</sub> to other entities, including gas left in equipment that is sold  |               |  |
| 7. Returns of SF <sub>6</sub> to supplier  |               |  |
| 8. SF <sub>6</sub> sent to destruction facilities  |               |  |
| 9. SF <sub>6</sub> sent off-site for recycling   |               |  |
| <b>C. Total Sales/Disbursements (6+7+8+9)</b>  | -             |  |
| <b>CHANGE IN NAMEPLATE CAPACITY OF EQUIPMENT</b>   |               |  |
|  | AMOUNT        | Comments   |
| 10. Total nameplate capacity (proper full charge) of <u>new</u> equipment                    |               |  |
| 11. Total nameplate capacity (proper full charge) of <u>retired</u> or <u>sold</u> equipment |               |  |
| <b>D. Change in Capacity (10 - 11)</b>   | -             |  |
| <b>TOTAL ANNUAL EMISSIONS</b>  |               |  |
|  | AMOUNT        | Tonnes CO <sub>2</sub> equiv. (lbs.SF <sub>6</sub> x23,900/2205) |
| <b>E. Total Emissions (A+B-C-D)</b>  | -             | -  |
| <b>Emission Rate (optional)</b>  |               |  |
|  | AMOUNT (lbs.) | Comments   |
| Total Nameplate Capacity at End of Year  |               |  |
|  | PERCENT (%)   |  |
| <b>F. Emission Rate (Emissions/Capacity)</b>   | -             |  |

# German Approach

High Voltage (above 52 kV)

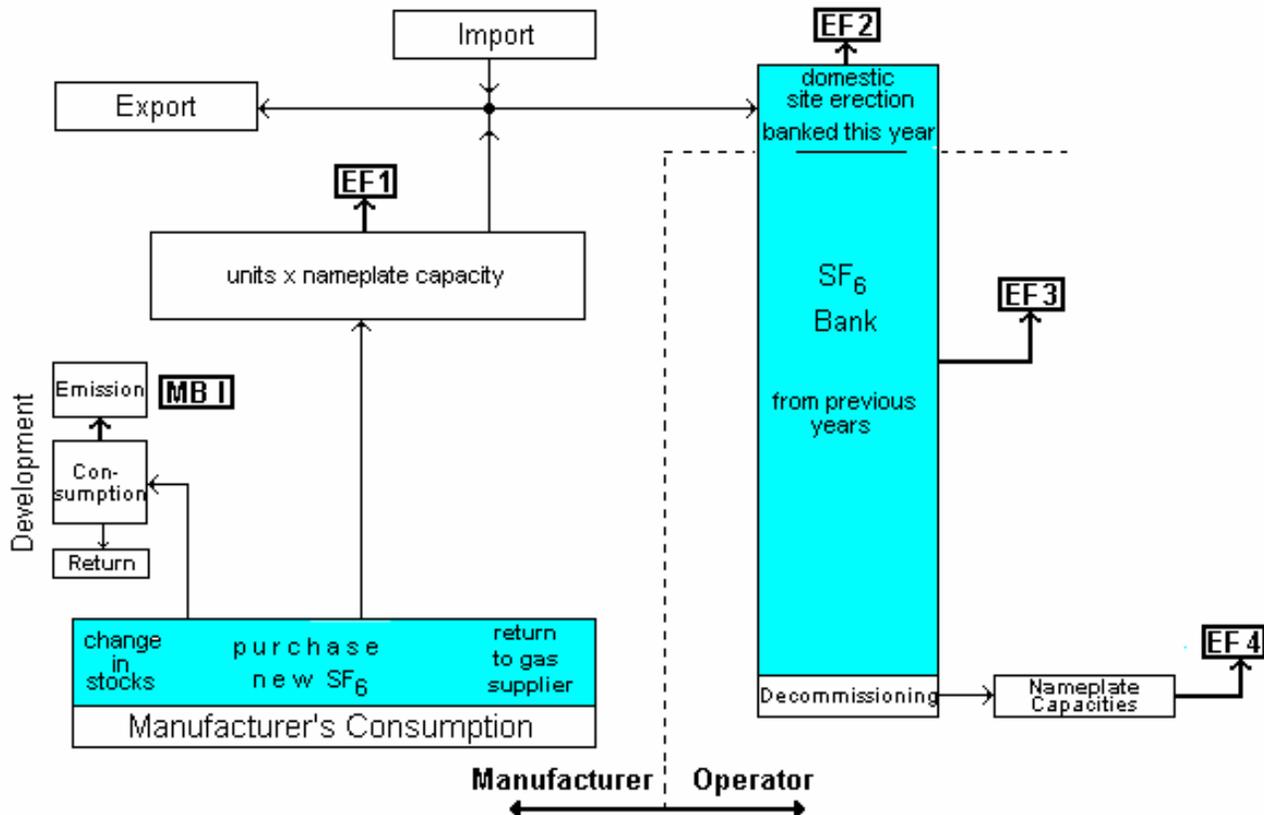
SF<sub>6</sub> Emission Estimation by Manufacturers and Operators



# German Approach (cont.)

Medium Voltage (up to 52 kV)

SF<sub>6</sub> Emission Estimation by Manufacturers and Operators



# Tier 2 and 3 Methods Require Long-Term Cooperation Among

- Inventory compilers
- Equipment manufacturers
- Equipment users
- Gas suppliers

# PFCs Also Included

- PFCs used in some transformers as dielectrics and heat transfer fluids
- $C_6F_{14}$  – Liquid
- Sometimes substitute for CFC-113
- Guidance for  $SF_6$  applies

# Other Products

- Military applications
  - AWACs
  - heat transfer fluids (PFCs)
- Research and medical particle accelerators
- Adiabatic applications (tires, sport shoes)
- Sound-proof windows
- Tracer gases

# Other Products (cont.)

- Guidance tailored to variety of emission profiles
  - Quick release of 100% (leak detection)
  - Brief storage (adiabatic—3 years)
  - Long storage (windows—25 years)

# 2006 Guidelines: Future Use

- IPCC adopted 2006 Guidelines in April
- Countries free, but not required, to use 2006 GL now
- 2006 GL are already having an influence beyond national inventories (CDM projects, corporate inventories)
- SBSTA will consider requirements and timing of full adoption next year.
- <http://www.ipcc-nggip.iges.or.jp/>