

# Remote Sensing Technology in Emissions Testing 遥感技术在尾气排放中的应用

ESP

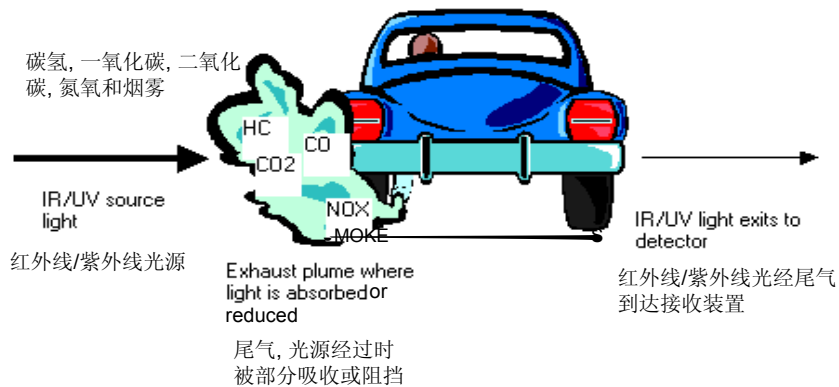


April 28, 2004  
AVECC Beijing



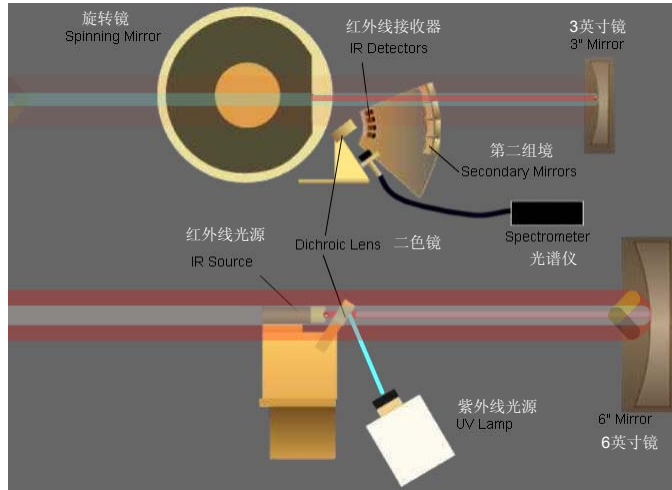
## Remote Sensing Device (RSD) Working Principles 遥感装置的工作原理

- Spectroscopy (Light Absorption) 光谱学 (光吸收)
- Beer-Lambert Law (Beer-Lambert 定律)
- Data output in concentrations (输出数据为浓度)

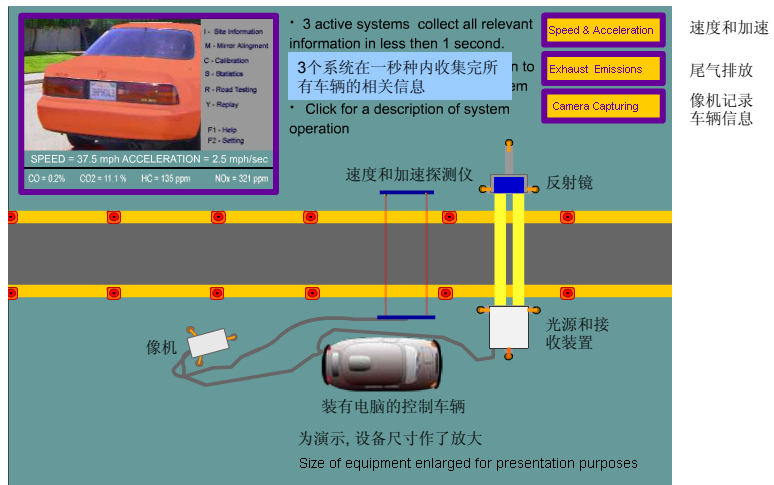




## Inside the Source-Detector Module 光源-接收模块的内部情况



## Operation of R-D 遥感系统的操作过程





## Deployment 布置



无人操作系统  
Unmanned system

Mobile system with  
Man Attended  
有人操作系统



## Applications 用途

- Application scope 用途范围
  - Light duty vehicles 轻型车辆
  - Heavy duty trucks and buses 重型卡车和客车
  - Others include motorcycles, trains, boats and planes 其它包括摩托车, 火车, 船和飞机
- Applications 用途
  - Gross emitter 高排放车辆
  - Clean screen 清洁车辆
  - (Cutpoints selection 限值的选定)
  - Program evaluation/fleet characterization 项目评估和车辆状况评估
- Applications Evolutions 用途的演化



## U - EPA Guidance Documents 美国环保署的指导文件 "Regulations" "法规"



### 1. Gross Emitter Identification – EPA/AA/AMD/EIG/96-01

发现高排放车辆

- I. United States: Texas (since '99), Virginia (July 2004)
- II. International: Taiwan (since 2002)



### 2. Clean Screening – EPA420-P-98-07

豁免清洁车辆

- I. United States: Missouri (since '90), Colorado (since 01)



### 3. Program Evaluation – EPA420-B-02-001

项目评估

- I. United States: Georgia (CIT "developed Reference Method")  
Colorado (UofD "developed Reference Method")  
Virginia (E-P applied Reference)  
British Columbia (E-P applied Reference)

### 4. International (Fleet Characterization) : Sri Lanka (03), Singapore (since 03), India (since 03).

国际(车辆状况评估)



## Identifying High Emitters – Results 发现高排放车辆-结果 "False Failure Rate" "误判的比例"

### 1. California R-D pull-over study results reported:

加州遥感即检即查研究结果报告

#### a. 1989 Lynwood:

86% of vehicles with R-D > 2% CO failed roadside inspection  
86%的遥感一氧化碳数据>2%的车辆在即检即查时排放未通过

#### b. CAQMD 1996:

95% of vehicles with R-D > 4% CO or 1,000 ppm HC failed IM240  
95%的遥感一氧化碳数据>4%或碳氢数据>1,000ppm的车辆排放未通过IM240测试

#### c. BAR 2001:

83-88% of vehicles with R-D > 2% CO or 1000ppm HC or 500 ppm NOx failed A-M  
83-88%的遥感一氧化碳数据>2%或氮氧数据>500ppm的车辆排放未通过A-M测试

### 2. Texas 2003:

97% of vehicles with R-D > 2.5-7.0% CO or 600-1,100ppm HC or 3,600-5,500ppm NOx failed A-M.  
97% 遥感检测结果>2.5-7.0% CO or 600-1,100ppm HC or 3,600-5,500ppm NOx未通过A-M检测



## Clean ~~greening~~ 豁免清洁车辆

Missouri 密苏里

1. ~~Started in St. Louis in April 2000~~ 2000年4月在 St. Louis 开始
2. Designed with IM240 和IM240一起设计
3. ~ 5M measurements annually 大约每年5百万次测量
  - a. ~~5 R-D 3000s (2 shifts total 14 hours/day)~~ 5台R-D 3000s 遥感设备(两班-每天14小时)
4. ~ 150k exemption notices annually 每年大约发出15万份豁免检测站检测通知
5. 20 to 25% of initial inspections 占首次检测的20-25%
6. < 4% loss in "excess emissions" <4%的不合格车辆被免检测站检测
  - a. Performance measured by 2% random audit 该评估采用了2%随机复检的方法
  - b. Cutpoints: 0.5%CO, 200ppmHC, 1,500ppmNOx 限值: 0.5%一氧化碳, 200ppm碳氢, 1,500ppm氮氧



## Reference Program Evaluation 供参考的项目评估情况

Virginia – Decentralized A-M 佛吉尼亚-非集中型A-M

- Northern Virginia I/M area sites vs. Richmond non-I/M area sites 北佛吉尼亚实施I/M制度地区和Richmond非I/M制度地区的比较
- 251 sampling days with total 680,641 valid readings taken 251取样天数共取得680,641个有效数据
- 23% of total registered fleet measured in I/M area sites and 14% of total registered fleet measured in non-I/M area sites 在I/M地区共抽查了23%的登记车辆在非I/M地区共抽查了14%的登记车辆
- Results with model year adjusted 车辆出厂年份调整后的结果
  - Non-I/M area sites are higher than I/M area sites by these %
 

	CO	HC	NOx
	12%	22%	15%

 非I/M地区比I/M地区尾气排放高出的%
  - Mid aged vehicles from 1985-1995 present larger difference 使用年限中等出厂年1985-1995的车辆体现最大的差别



## Program Evaluation 项目评估

British Columbia – Centralized I/M240 & A-M Correlations 集中型的  
I/M240和A-M的相关性

- I/M240 Correlations I/M240相关性
    - R-D mostly after I/M240 tests 遥感检测大都在I/M240检测之后
    - Average emissions by model year 根据车辆出厂年的平均排放值
    - 1992 – 2001 models 1992-2001出厂的车辆
    - Model year average correlation, R<sup>2</sup>: 平均相关性  
CO: 0.96, HC: 0.98, NOx: 0.99
  - A-M Correlations A-M相关性
    - R-D mostly after A-M tests 遥感检测大都在A-M检测之后
    - 1991 and older 车辆为1991年以后出厂
    - 1980 and older as a single point 1980及以后出厂的车辆只作为一组
    - Good CO and NOx correlation, R<sup>2</sup>: 好的一氧化碳和氮氧相关性  
CO:0.96, HC:0.71, NOx:0.91
    - A-M values lower than R-D for HC and CO: A-M的碳氢和一氧化碳数据低于遥感数据
- Possible Reasons 可能的原因
- i. Post I/M Deterioration 在I/M检测后车辆性能的下降
  - ii. A-M conditioning may influence vehicles towards the A-M standard  
A-M的测试条件有可能影响车辆往A-M标准方向靠拢
  - iii. R-D vs. A-M analyzer technology and scaling 遥感和A-M采用的分析仪技术和缩放比例



## International Programs & Studies

国际项目和研究

- Brazil (Sao Paulo) – Later in 2004 巴西(圣保罗) 2004年底实施
  - Phase 1 – Fleet Characterization 第一阶段-车辆状况评估
    - 1 year 一年
  - Phase 2 – Gross Emitter Identification 第二阶段-发现高排放车辆
    - Coincides with start of I/M program 与I/M制度的实施同步
  - Phase 3 – Clean Screening 第三阶段 豁免清洁车辆
    - If deemed useful and necessary 如果认为有效和必须
- Sri Lanka (2003) – U-AID funded 斯里兰卡(2003年)
  - Fleet Characterization Preceded I/M Program 在I/M制度实施之前的车辆状况评估
- India (2003) – U-AID funded 印度
  - Fleet Characterization (on-going) 持续进行的车辆状况评估
- Singapore (2003) – Singapore Govt. funded 新加坡
  - Fleet Characterization (on-going) 持续进行的车辆状况评估
- Hong Kong (2003) – HKEPD funded 香港
  - Fleet Characterization 车辆状况评估



## For More Information 若需进一步信息

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## Beer-Lambert Law

$$I = I_0 e^{-k\lambda * N}$$

OR

$$I/I_0 = T = e^{-k\lambda * N}$$

Where

$I_0$  is incident light power into the gas.

$I$  is measured incident light power out of the gas.

$K_\lambda$  is gas absorption coefficient at wavelength  $\lambda$ .

$N$  is number of gas molecules per unit cross-section of the measurement beam.

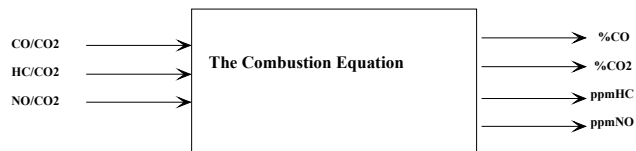
$T$  is transmittance, the ratio of output to input power.

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## Concentration Reporting

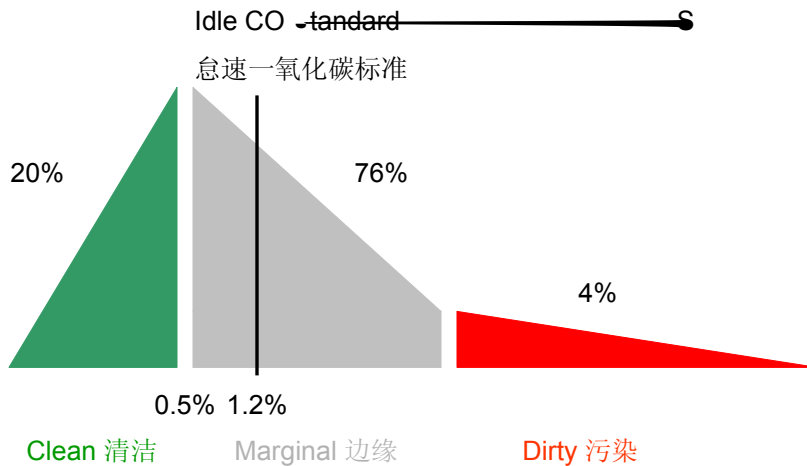
- The “amounts” (number of molecules) of gas present for CO, CO<sub>2</sub>, HC, and NO are measured,
- The gas ratios are formed,
- Three gas ratios are used in the “Combustion Equation” to produce Four reported gas concentrations,
- ~~Smoke is measured by smoke factor~~ which is essentially measured opacity divided by the measured amounts of CO<sub>2</sub>, CO, and HC in the exhaust (how much fuel burnt).



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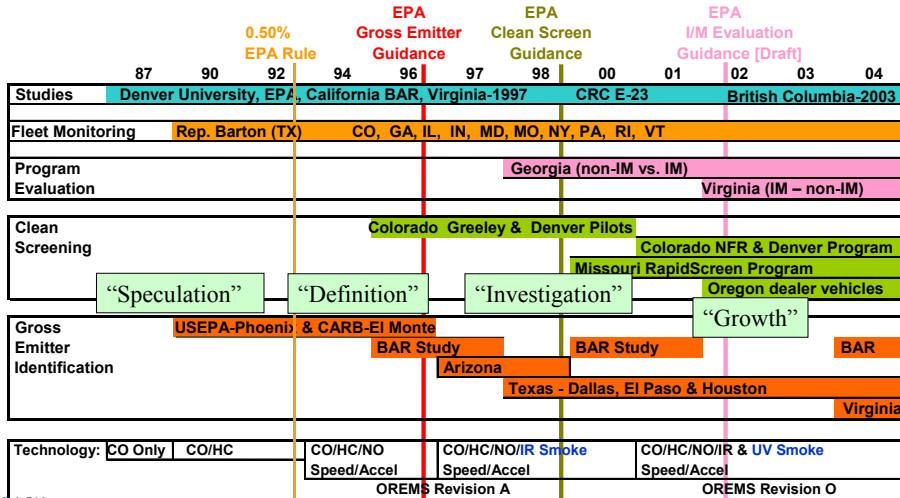
## Cutpoints Selection 限值的選擇



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# History of Remote Sensing (in the U.S.A)



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