

Presentation to the MCERTS 2007 Conference, Bretby, England.

**EMISSIONS MONITORING USING FTIR -
PRACTICAL USE OF THE ASTM D6348
METHOD**

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OUTLINE

FTIR BASICS

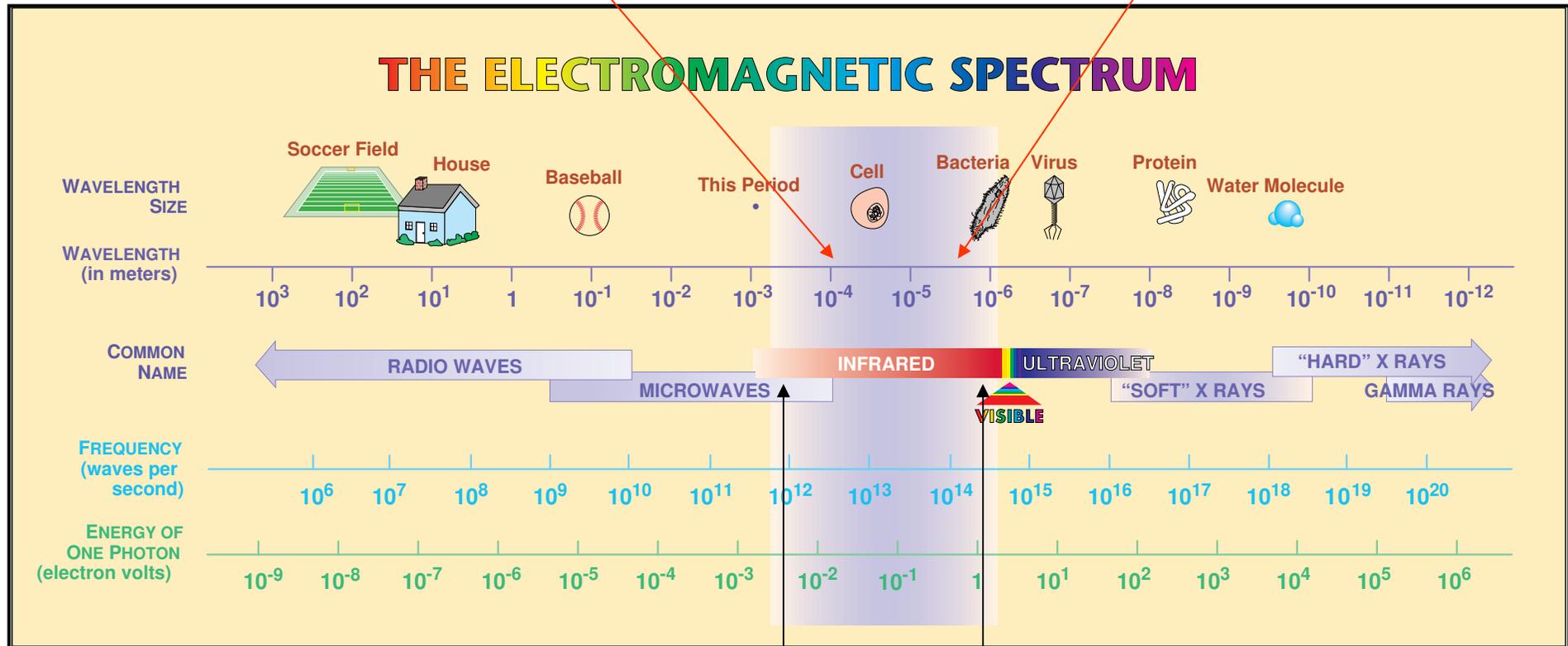
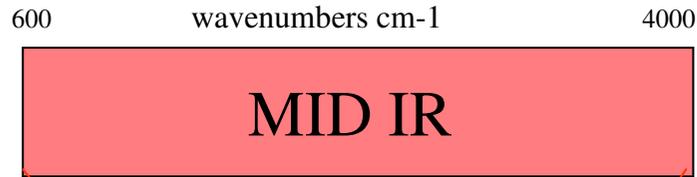
FTIR AND 'M2'

THE ASTM METHOD AND MCERTS

COMMENTS AND CONCLUSIONS

FTIR BASICS

Mid IR detects
chemical bonds

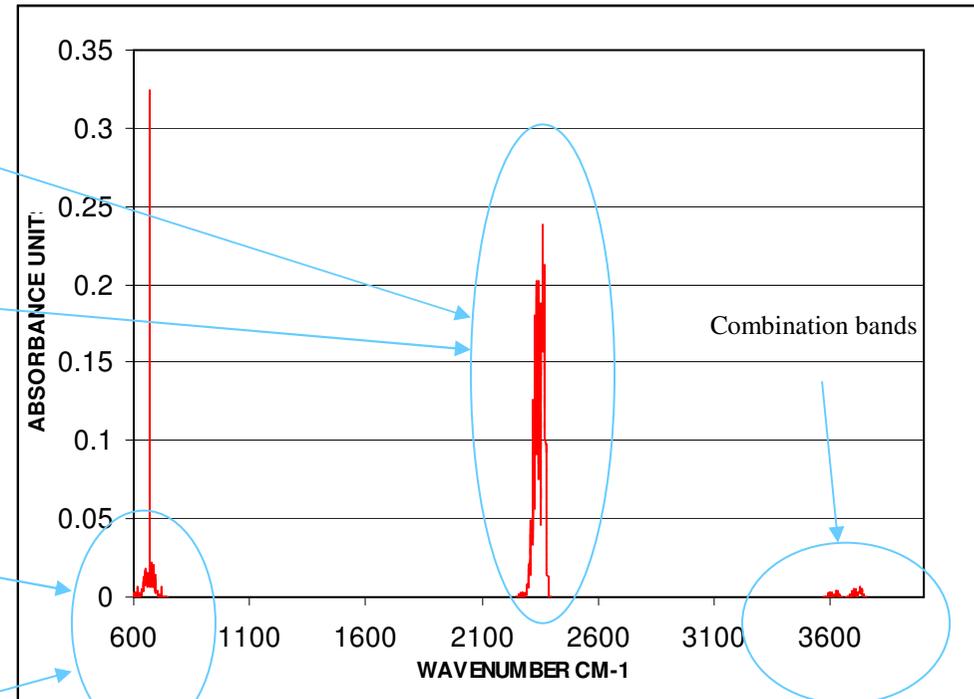
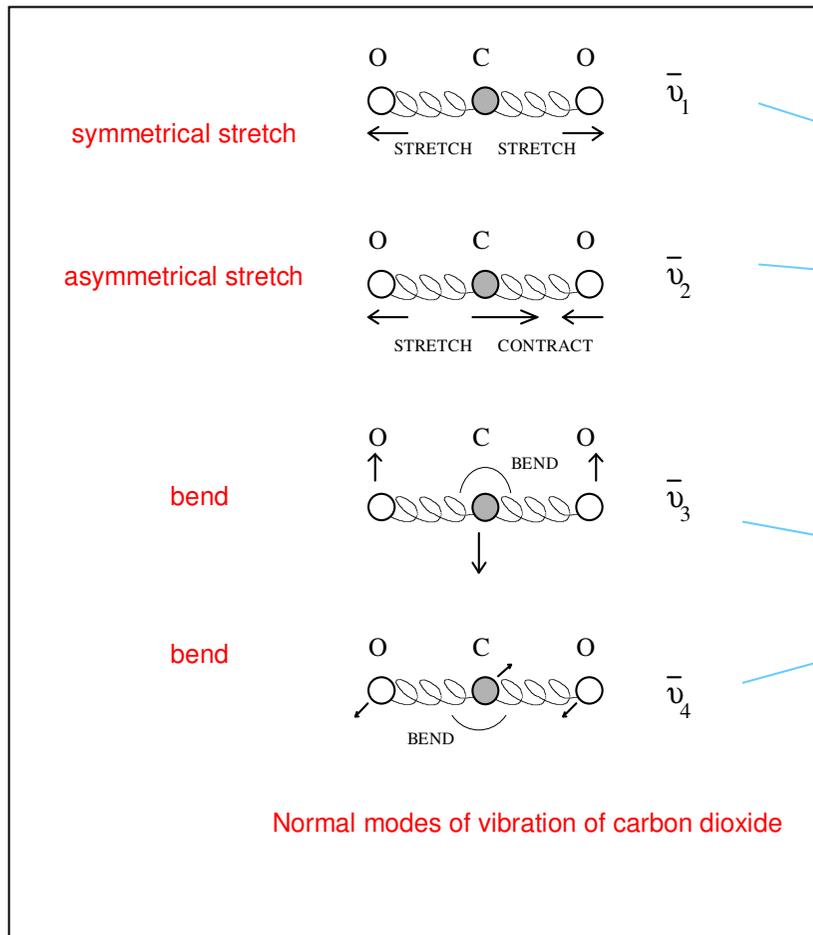


IR units: wavenumbers (cm^{-1})
 10^{-5} metres wavelength = 1000 cm^{-1}

Near-IR: $4000 - 14000 \text{ cm}^{-1}$

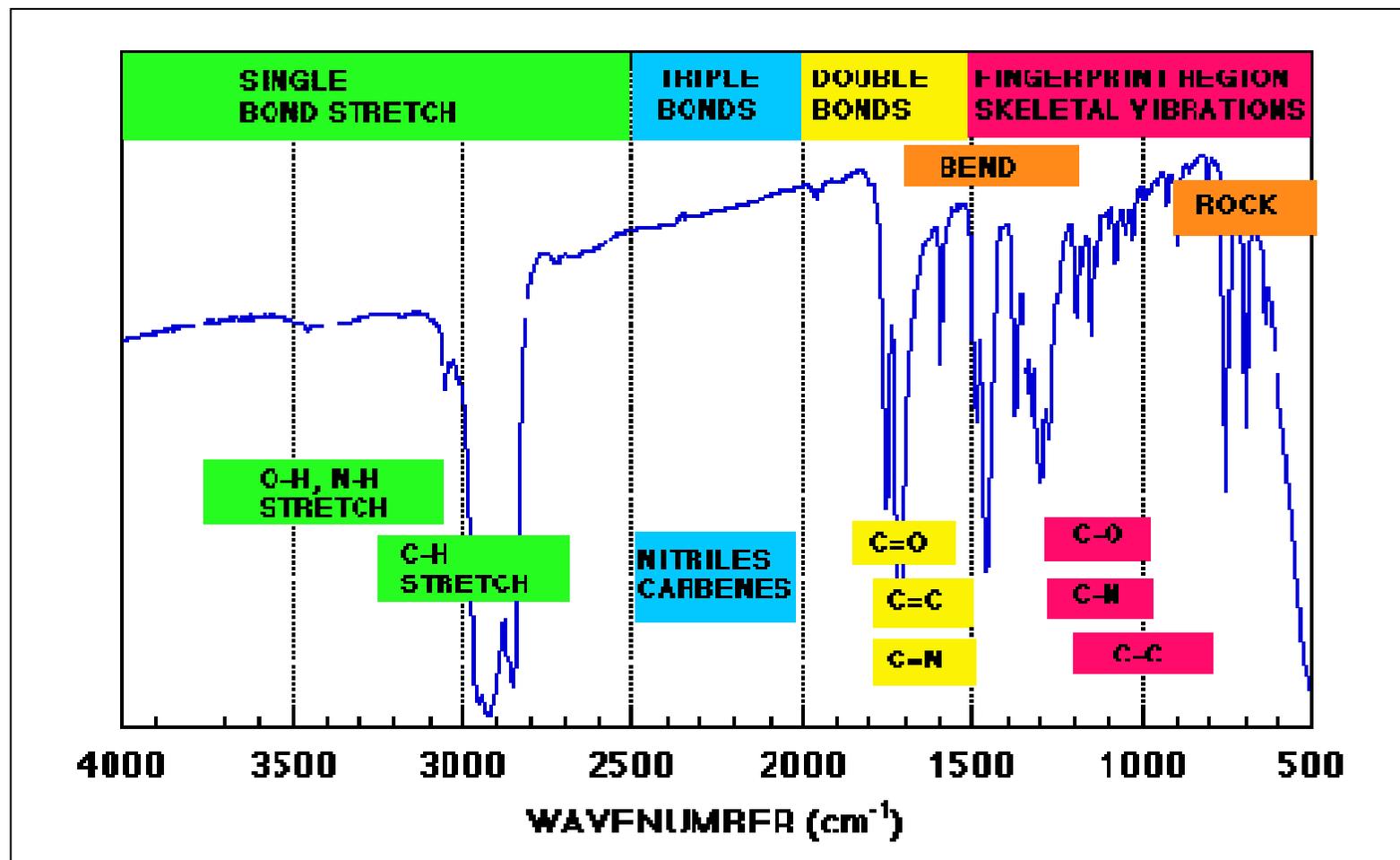
Far-IR: $5 - 500 \text{ cm}^{-1}$

- Molecules have natural vibration frequencies as bonds vibrate
- IR frequencies matching these are absorbed

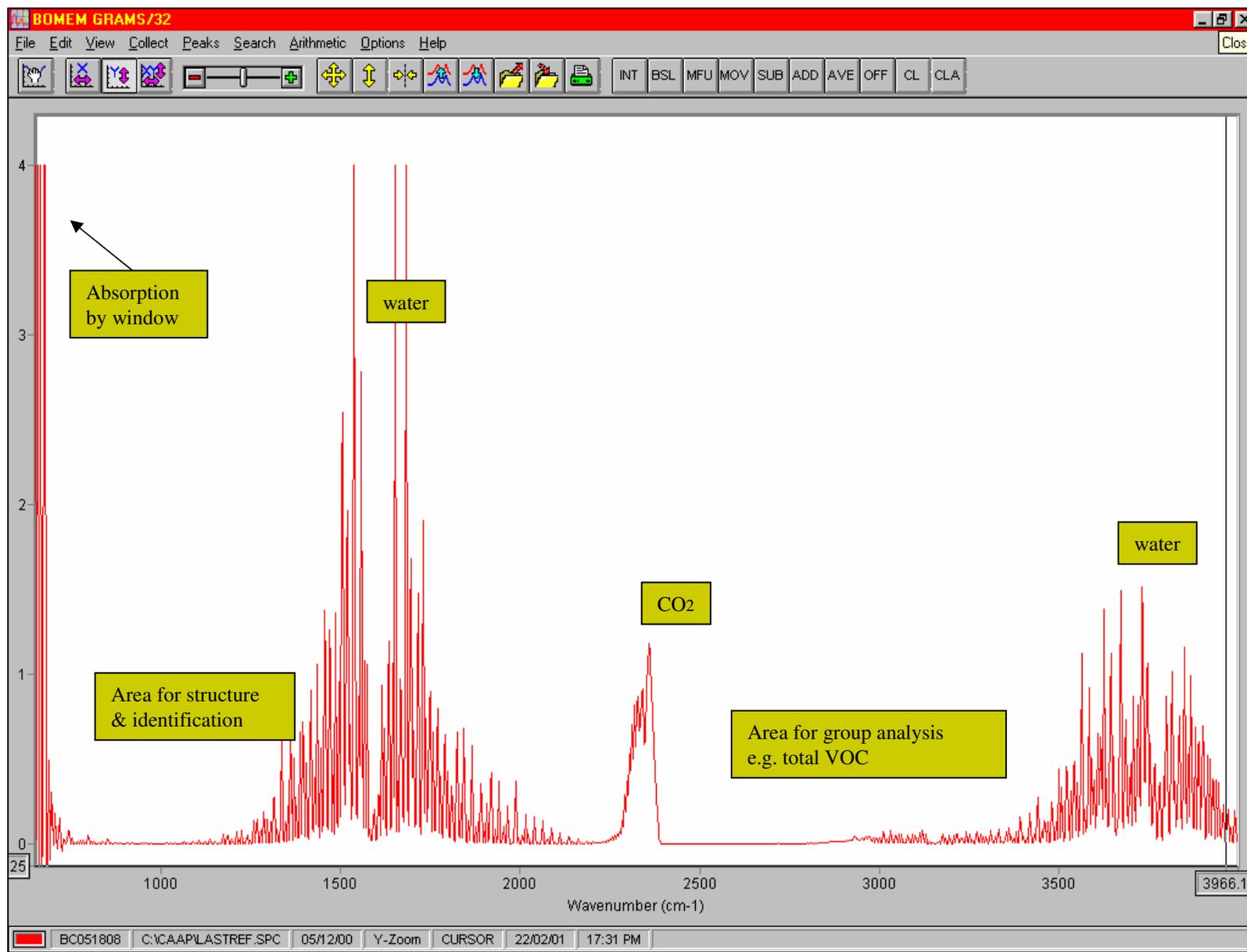


Different bonds give different absorption frequencies

**ABSORBANCES CHARACTERISTIC OF BOND TYPE
CAN BE USED FOR SIMPLE IDENTIFICATION
SMALL VARIATIONS DEPEND ON 'ENVIRONMENT' SURROUNDING BOND**



PRACTICAL IR SPECTROMETRY



BENEFITS OF FTIR

- **Can be used for wide range of organic/inorganic gases**
 - **Identification**
 - **Quantification**
- **Quick measurement ~ 1 sec**
- **Allow transfer of calibration spectra**
- **Very stable - excellent repeatability**
- **Reliable and robust**
- **Calibration drift very low**

**WHAT DOES
MONITORING GUIDANCE M2
SAY ABOUT FTIR ?**

Periodic Instrumental Techniques

- FTIR is an authorised technique for many components in M2**



ASTM D6348 is the preferred method

FTIR MONITORING

There are 2 broad application areas:

- **black box 'routine' use as a replacement for other instruments and methods**
- **exploratory use to characterise a complex gas mixture**

THE ASTM METHOD

THE ASTM METHOD – INITIAL COMMENTS

**Accreditation to the standard not easy
Requires significant degree of
interpretation**

**Current industry effort by the Environment
Agency, STA and interested parties is to
produce a new UK standard based on
ASTM but specific for UK stack testing
Aim: Draft by September**

OVERVIEW

FTIR TEST PLAN



PRE-TEST CHECKS



EMISSIONS TEST



POST-PROJECT
DATA REVIEW

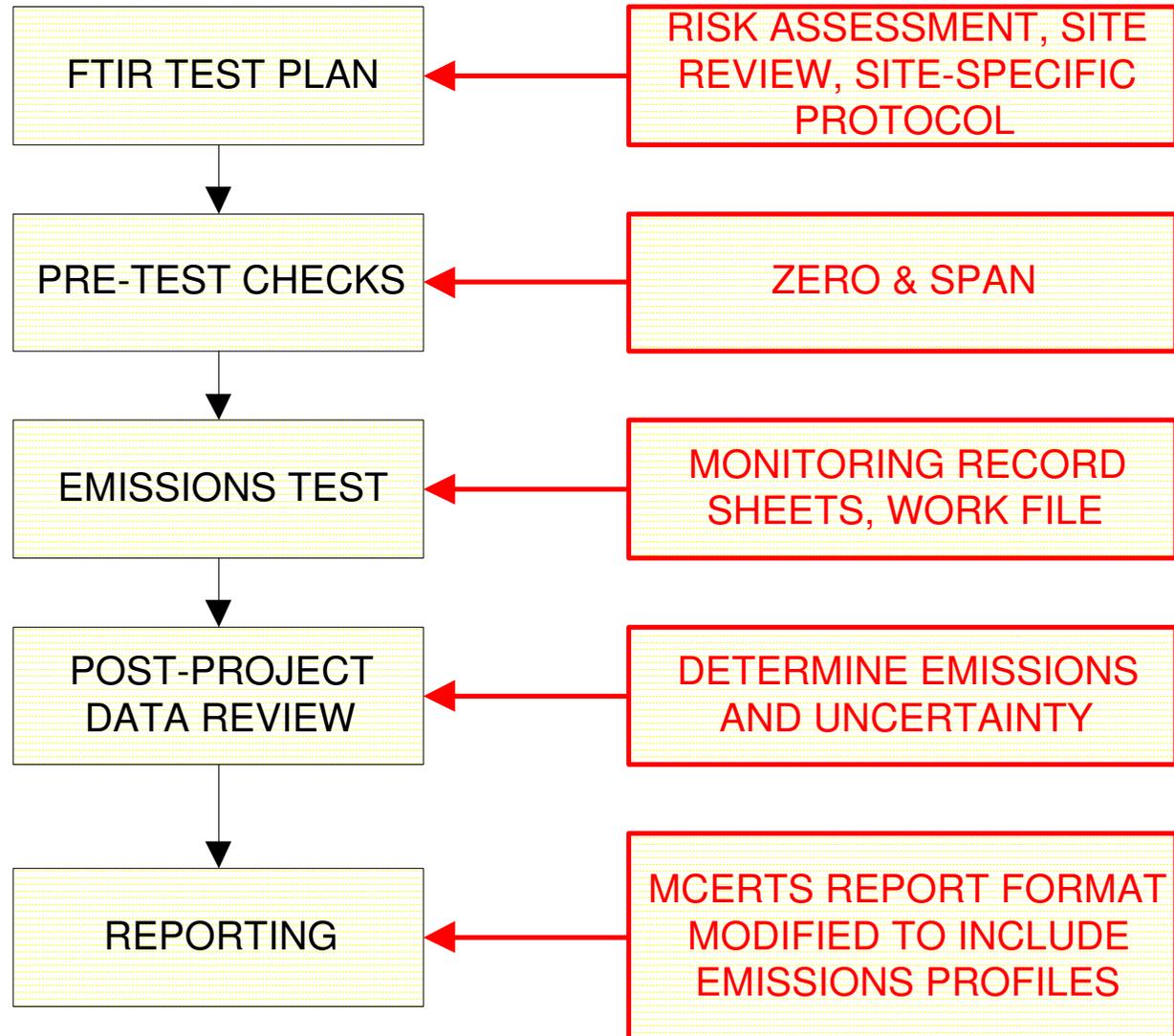


REPORTING

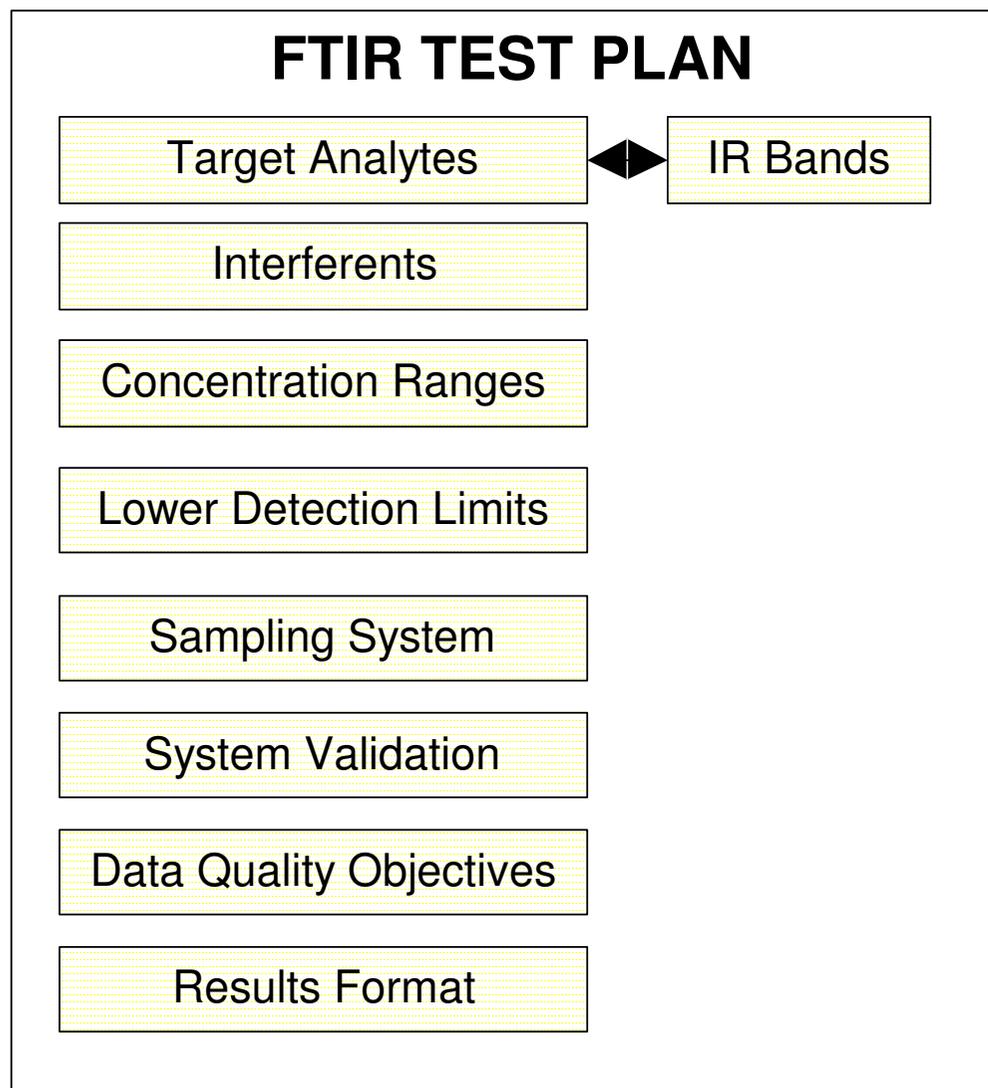
**The method needs adapting to fit
the requirements of MCERTS....**

ASTM METHOD

MCERTS



FTIR TEST PLAN:



PRE-TEST CHECKS:

- **Nitrogen purge**
- **Collect background spectrum**
- **Perform system zero check**
- **Perform system span check**
 - **measure mechanical response time**
 - **check span concentration**
- **Perform system calibration check**
 - **use certified gas standard**
- **If required, do analyte spiking**

ANALYTE SPIKING – For Critical Components:

- **Sample direct into the analyser**
- **Spike calibration standard direct into analyser**
- **Spike CS into the sampling system**
 - **blend with stack gas**
 - **rules on concentration of spike gas**
 - **rules on flow of spike gas**
- **Check readings**
- **Determine bias**
- **Determine % Spike Component Recovery**

•NOTE: Analyte spiking is not present in other CEN standards and may be withdrawn as a requirement for FTIR by the FTIR Working Party on the new FTIR method

**NOW YOU'RE READY TO START
THE EMISSIONS TEST
(SAMPLE)**

EMISSIONS TEST:

- **Analyser tends to run alone**
- **Quality assurance**
 - zero and span checks
- **Complete work records**



POST PROJECT DATA REVIEW:

- **May depend on how the analyser was used – black box ‘routine’ or exploratory**
 - Select representative spectra**
 - Check resolution and noise**
 - Compare to reference spectra**
 - Check for interferences**
 - Calculate concentrations manually**
- Also.... Calculate uncertainty**
 - **Model**
 - **System**

REPORTING

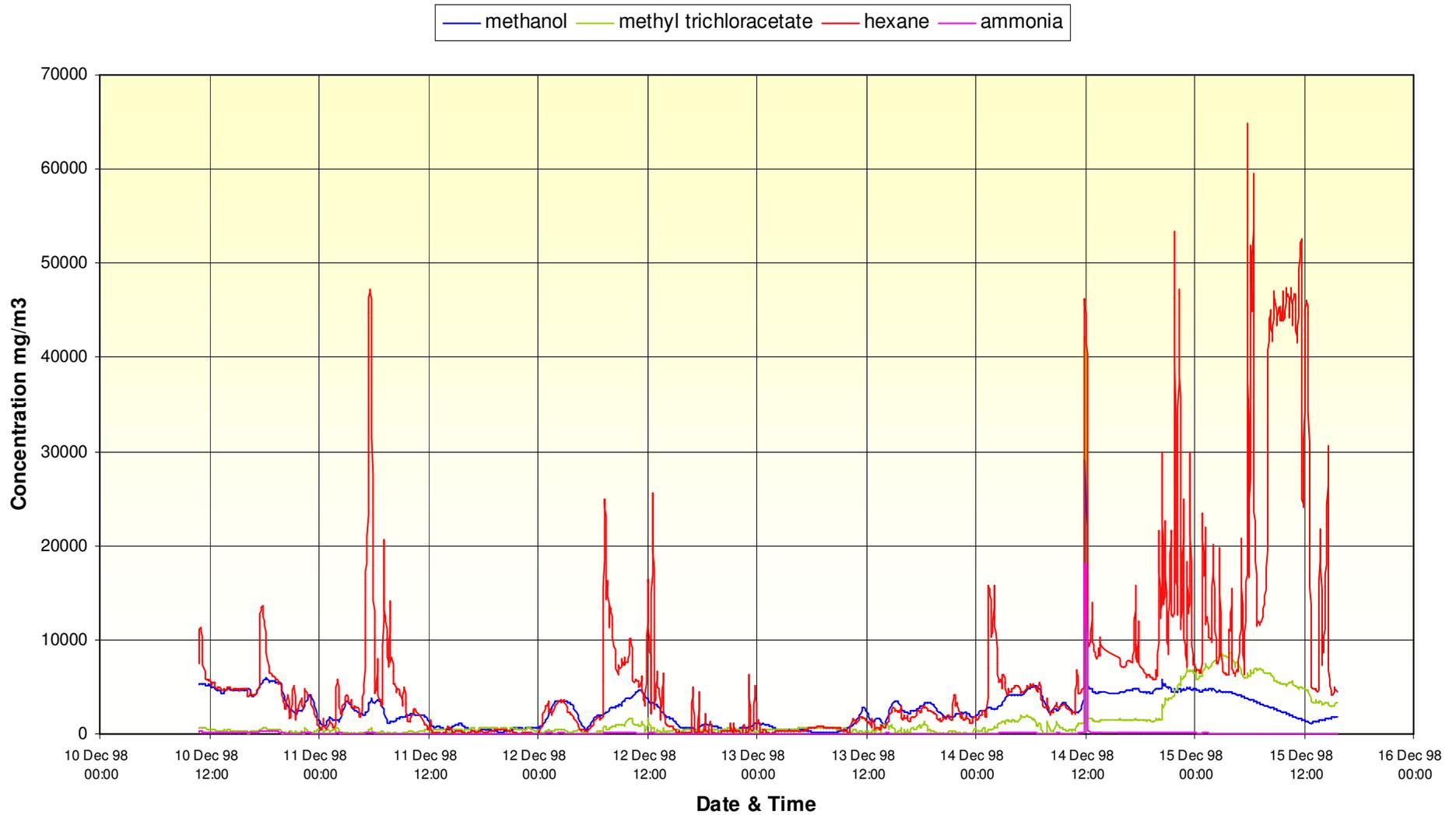
Follow standard MCERTS report format.

- Emissions profiles go into Part2: Supporting Information, supplied to client



Process Profiling - concentration profile

Concentration Profile



COMMENTS

- **Method is open to some interpretation**
- **Analyte spiking is not a usual feature of CEN Standards**
- **Minimum Detectable Concentration can be confusing**
- **Uncertainty budget is difficult to calculate, as theoretically, it varies with every spectrum**

FTIR Working Party

- **Developing best practice in FTIR use**
- **Focusing on the needs of the monitoring industry**
- **Looking forward to develop a MID document and maybe more**

CONCLUSIONS

- **ASTM Method is difficult to set up**
- **Method does fit into MCERTS approach**
- **Once setup, emissions test proceeds more easily**
- **Simple regular checks**
- **One analyser can be used for many components**
- **You can check spectra after test**
- **MID document in preparation will help FTIR users**