

## VAMDC Workshop – Vienna 16 – 18 February 2011

### Summary of proposed changes to the XSAMS Schema

1. Refer to “sources” by element rather than attribute.

e.g.

```
<SomeData>
  <Value>0.</Value>
  <SourceRef>Bref1</SourceRef>
  <SourceRef>Bref2</SourceRef>
  ...
</SomeData>
```

instead of

```
<SomeData sourceRef="Bref1">
  <Value>0.</Value>
</SomeData>
```

This apparently makes it easier to refer to more than one source than an `xs:IDREFS` attribute type would and is easier for users to loop over.

2. Xsams.xsd in the vamdc-working subversion branch now has a `targetNamespace`:

<http://xsams.svn.sourceforge.net/viewvc/xsams/branches/vamdc-working>

To make this work and play nicely with unqualified attributes, all the attribute definitions have to be converted into ordinary simpleTypes. e.g.

```
<xs:simpleType name="methodRefType">
  <xs:restriction base="xs:IDREF">
    <xs:pattern value="M.+"/>
  </xs:restriction>
</xs:simpleType>
```

instead of

```
<xs:attribute name="methodRef">
  <xs:simpleType>
    <xs:restriction base="xs:IDREF">
      <xs:pattern value="M.+"/>
    </xs:restriction>
  </xs:simpleType>
</xs:attribute>
```

3. `DataType` is now a choice between a `<Value>`, `<Accuracy>` pair or `<FitParameters>`, in order that an item of data which is to be calculated from a given function may be specified. For example, a particular quantity,  $D$ , might be calculated from a function

$$D = F(x, y; a, b, c) = ax^2 + bxy + cy^2,$$

in which  $x, y$  are the function *arguments* and  $a, b, c$  function *parameters*. The function itself may be defined within the existing <Function> element; the DataType definition of  $D$  then takes the form:

```
<D>
  <FitParameters functionRef="Ffunc">
    <FitArgument units="...">
      <Name>x</Name>
      <LowerLimit units="...">...</LowerLimit>
      <UpperLimit units="...">...</UpperLimit>
    </FitArgument>
    <FitArgument units="...">
      <Name>y</Name>
      <LowerLimit units="...">...</LowerLimit>
      <UpperLimit units="...">...</UpperLimit>
    </FitArgument>
    <FitParameter name="a">
      <SourceRef>...</SourceRef>
      <Value units="...">...</Value>
      <Accuracy>...</Accuracy>
    </FitParameter>
    <FitParameter name="b">
      <SourceRef>...</SourceRef>
      <Value units="...">...</Value>
      <Accuracy>...</Accuracy>
    </FitParameter>
    <FitParameter name="c">
      <SourceRef>...</SourceRef>
      <Value units="...">...</Value>
      <Accuracy>...</Accuracy>
    </FitParameter>
  </FitParameters>
</D>
```

4. A <NamedDataType> has been introduced, which extends <DataType> by adding an attribute, name.
5. The <States> tag has been changed to <Species>, for the love of God.
6. AtomicIonType and MoleculeType now carry a mandatory attribute, speciesID, matching /X.+/, which can be referenced elsewhere in the XSAMS document with the speciesRef attribute.
7. MolecularChemicalSpecies now contains the optional element InChI and mandatory element InChIKey for identification.
8. MolecularChemicalSpecies now contains an element MoleculeStructure containing the CML elements cml:atomArray and cml:bondArray identifying the molecular structure (connectivity

and/or equilibrium atom ( $x,y,z$ ) coordinates) and labelling the atoms for reference when giving e.g. hyperfine coupling quantum numbers. The CML elements reside in their own namespace (<http://www.xml-cml.org/schema>) which should be declared if used.

9. Two more 'cases' have been introduced within the case-by-case formulation for molecular states: those for open-shell, non-linear triatomic molecules (nltos) and open-shell, linear polyatomic molecules (lpos). The attribute `group` has been added to some symmetry elements for which it is relevant. Full documentation of the case-by-case Schemata is at <http://xsams.svn.sourceforge.net/viewvc/xsams/branches/ucl-branch/docs/cbc-doc-0.2.1.pdf>
10. An `Environments` element, at the top level of the XSAMS tree, has been introduced to describe one or more conditions of temperature, pressure and composition for reference. For example,

```
<Environment envID="Eair">
  <Temperature>
    <Value units="K">298.</Value>
  </Temperature>
  <TotalPressure>
    <Value units="atm">1.</Value>
  </TotalPressure>
  <Composition>
    <Species name="N2">
      <MoleFraction>
        <Value units="unitless">0.79</Value>
      </MoleFraction>
    </Species>
    <Species name="O2">
      <MoleFraction>
        <Value units="unitless">0.21</Value>
      </MoleFraction>
    </Species>
  </Composition>
</Environment>
```

The species may also be referred to by `speciesRef` (see above), and composition specified by `PartialPressure`, `MoleFraction`, or `Concentration`.

11. Line broadening is contained within the `Broadenings` element, and consists of one or more of
  - a. `StarkBroadening`
  - b. `VanDerWaalsBroadening`
  - c. `NaturalBroadening`
  - d. `InstrumentBroadening`

Each `Broadening` references an environment (through the `envRef` attribute) and contains one or more `Lineshape` elements. `Lineshapes` are identified through the `name` attribute and contain one or more

LineshapeParameter (of type NamedDataType) also named by attribute. Examples:

```
<StarkBroadening envRef="EHe">
  <Lineshape name="Lorentzian">
    <LineshapeParameter name="gammaL">
      <SourceRef>BStarkB</SourceRef>
      <Value units="A">0.008</Value>
      <Accuracy>0.001</Accuracy>
    </LineshapeParameter>
  </Lineshape>
</StarkBroadening>
```

For the Lorentzian HWHM given as a function of pressure and temperature:

$$\gamma_{\text{air}}(p, T) = \gamma_{\text{air}}^{\text{ref}}(p_{\text{ref}}, T_{\text{ref}}) \cdot (p/p_{\text{ref}}) \cdot (T_{\text{ref}}/T)^{n_{\text{air}}}$$

```
<VanDerWaalsBroadening envRef="Eair">
  <Lineshape name="Lorentzian">
    <Comments>The temperature-dependent pressure broadening
      Lorentzian lineshape</Comments>
    <LineshapeParameter name="gammaL">
      <FitParameters functionRef="FgammaL">
        <FitArgument units="K">
          <Name>T</Name>
          <LowerLimit units="K">240</LowerLimit>
          <UpperLimit units="K">350</UpperLimit>
        </FitArgument>
        <FitArgument units="K">
          <Name>p</Name>
          <LowerLimit units="atm">0.</LowerLimit>
          <UpperLimit units="atm">1.2</UpperLimit>
        </FitArgument>
        <FitParameter name="gammaL_ref">
          <SourceRef>B_HIT-HF-g_air-2</SourceRef>
          <Value units="1/cm">0.105</Value>
          <Accuracy>0.0021</Accuracy>
        </FitParameter>
        <FitParameter name="n">
          <SourceRef>B_HIT-HF-n_air-0</SourceRef>
          <Value units="unitless">0.55</Value>
          <Accuracy>None</Accuracy>
        </FitParameter>
      </FitParameters>
    </LineshapeParameter>
  </Lineshape>
</VanDerWaalsBroadening>
```

12. Line shifting data is placed within a Shiftings element, which contains one or more Shifting elements, each containing one or more ShiftingParameter elements (of NamedDataType). Each Shifting element carries an envRef attribute, to reference the shifting environment.

13. Basic types, `VectorType` and `MatrixType` have been introduced to represent Cartesian vectors and general matrices. e.g.

```
<Vector ref="..." x3="0." y3="1." z3="-2."/>

<SomeMatrix units="..." nrows="n" ncols="n" form="symmetric"
  values="real">
  <RowRefs>row_1 row_2 row_3 ... row_n</RowRefs>
  <ColRefs>col_1 col_2 col_3 ...col_n</ColRefs>
  <Matrix>0. 0. 1. -4. 2. ... -3. 0.</Matrix>
</SomeMatrix>
```

values can be real, imaginary or complex. form identifies the type of matrix (symmetric, skew-symmetric, diagonal, etc.) and hence the number of (whitespace-delimited) values it is necessary to give within the `<Matrix>` tag (e.g.  $n(n+1)/2$ ,  $n$ ,  $n^2$ , etc.)

14. Basic types `DataListType` and `LinearSequenceType` represent simple lists of numerical data:

```
<DataList n="100" units="Mb">0. 0.13 0.12 0.08 ...
  1.20</DataList>
<LinearSequenceType n="101" a0="500." a1="0.1"/>
```

The latter example represents the sequence (arithmetic progression):  
500. 500.1 500.2 ... 510.0

15. A `DataSetType` contains one of `DataList`, `LinearSequence`, or the name of an external file (containing the whitespace-delimited data in text format) along with either an `ErrorList` (giving accuracies for each data point) or a single `Error` (if the same accuracy applies to every data point).
16. A `SimpleDataTableType` contains one or more `DataSetTypes` called X and one or more `DataSetTypes` called Y.
17. An element, `CrossSection`, has been added to `RadiativeType`. It is an extension of `SimpleDataTableType`, with additional attributes to refer to species (`speciesRef`) and environment (`envRef`), and assigns vibrational bands through a `BandAssignment` element. E.g

```
<CrossSection id="azulene-paxs">
  <SourceRef>B_TCSD1</SourceRef>
  <SpeciesRef>X-CUFNKYGDVFPVPHO-UHFFFAOYAT</SpeciesRef>
  <Description>Photoabsorption cross section of
    azulene</Description>
  <X parameter="photon energy" units="eV" id="D-eV-series1">
    <LinearSequence n="601" units="eV" a0="0." a1="0.05"/>
  </X>
  <Y parameter="sigma" units="Mb">
    <DataList n="601" units="Mb">
```

```

0 -1.3588884e-05 0.00029940086 0.0018259565 ...84.611003
  </DataList>
  <Error>1.e-7</Error>
</Y>
</CrossSection>

```

18. One or more BandAssignment elements identify broad features in the spectrum by their central position and width, and gives assignments by reference to the normal modes listed in MolecularChemicalSpecies. e.g.

```

<CrossSection>
... [Cross section data] ...
<BandAssignment name="2v1+v2">
  <BandCentre>
    <Value units="1/cm">410</Value>
    <Accuracy>2</Accuracy>
  </BandCentre>
  <BandWidth>
    <Value units="1/cm">40</Value>
    <Accuracy>5</Accuracy>
  </BandWidth>
  <Modes>
    <DeltaV modeID="v1">2</DeltaV>
    <DeltaV modeID="v2">1</DeltaV>
  </Modes>
</BandAssignment>
</CrossSection>

```

19. NormalModes resides within MolecularChemicalSpecies and lists the molecule's normal mode frequencies, intensities, and displacement vectors. e.g.

```

<NormalModes electronicStateRef="SX_Azulene-1">
  <NormalMode id="v1" pointGroupSymmetry="A1">
    <HarmonicFrequency>
      <Value units="1/cm">162</Value>
      <Accuracy>1</Accuracy>
    </HarmonicFrequency>
    <Intensity>
      <Value units="km/mol">0</Value>
    </Intensity>
    <DisplacementVectors units="Å">
      <Vector ref="C1" x3="0." y3="0.001" z3="0.0005"/>
      <Vector ref="C2" x3="0.01" y3="-0.001" z3="0.0005"/>
      <Vector ref="C3" x3="-0.005" y3="0.001" z3="0."/>
      <!-- etc... -->
    </DisplacementVectors>
  </NormalMode>
</NormalModes>

```

20. The anharmonicity tensor is given within a MatrixData element, within MolecularChemicalSpecies. It lives inside the StableMolecularProperties/OtherProperties tag. e.g.

```

<StableMolecularProperties>
  <OtherProperties>

```

```

<Name>Anharmonicity Tensor</Name>
<MatrixData units="1/cm" nrows="48" ncols="48"
             form="symmetric" values="real">
  <RowRefs>v1 v2 v3 ... v48</RowRefs>
  <ColRefs>v1 v2 v3 ... v48</ColRefs>
  <Matrix>
    10.43 2.45 -4.01 0.49 -78.9 ... 12.4
  </Matrix>
</MatrixData>
</OtherProperties>
</StableMolecularProperties>

```

21. The PartitionFunctionType defines tables of temperature-dependent partition functions for atoms and molecules. The PartitionFunction element may be used within MolecularChemicalSpecies. e.g.

```

<PartitionFunction>
  <T parameter="Temperature" units="K">
    <DataList n="15" units="K">100. .. 1500.</DataList>
  </T>
  <Q parameter="Partition Function" units="unitless">
    <DataList n="15" units="unitless">56.432 154.342 ...
      3445.321</DataList>
  </Q>
</PartitionFunction>

```

22. MolecularState also has a StateExpansion element to give the coefficients of a linear expansion in terms of some basis. e.g.

```

<StateExpansion>
  <Coeff stateRef="Sbb1">0.7071</Coeff>
  <Coeff stateRef="Sbb2">0.7071</Coeff>
</StateExpansion>

```

The basis itself is a list of MolecularState elements within Molecule. e.g.

```

<BasisStates>
  <MolecularState stateID="Sbb1">
    <dcs:QNs>
      <dcs:v>0</dcs:v>
      <dcs:J>3</dcs:J>
      ...
    </dcs:QNs>
  </MolecularState>
  <MolecularState stateID="Sbb2">
    <dcs:QNs>
      <dcs:v>0</dcs:v>
      <dcs:J>4</dcs:J>
      ...
    </dcs:QNs>
  </MolecularState>
</BasisStates>

```

```
</MolecularState>  
</BasisStates>
```