# Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

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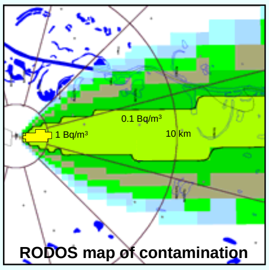
# Validation Studies With RODOS / ATSTEP

## REALTIME ONLINE DECISION SUPPORT SYSTEM FOR NUCLEAR EMERGENCY MANAGEMENT (www.rodos.fzk.de)



Results of dispersion calculations with **RODOS-ATSTEP** were compared with series of hourly dispersion data from the Validation Kit: the Copenhagen, Indianapolis, and Kincaid data sets.

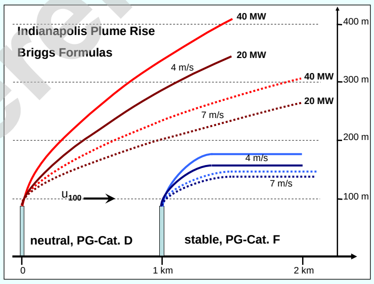
ATSTEP is a Gaussian puff model code designed for calculation of dispersion and deposition of radioactive releases to the atmosphere (NPP- and Transport Accidents, Dirty bomb). In RODOS it is coupled to complex NWP data and multi-nuclide source terms in an automatic real-time on-line mode with 10 minutes cycles.
The diffusion parameters used are the **Karlsruhe-Jülich** (KJ)-, $z_0$ = 1.5m, and the **Mol**-set, $z_0$ < 1m.




Thermal buoyancy and initial momentum lead to rising trajectories of puffs, calculated in ATSTEP with **BRIGGS** formulas for plume rise.

The diagram on the right shows plume rise curves for typical conditions in the Indianapolis data set with neutral and stable conditions, different heat power emission, and wind speeds.

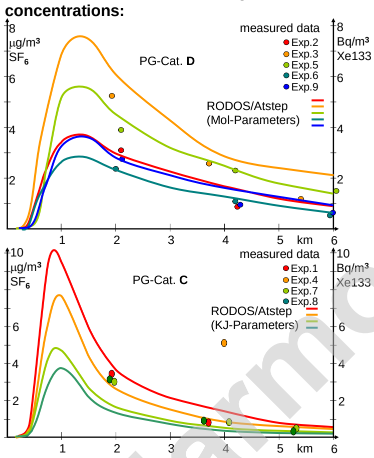
The stack height of the Perry K power station is 84 m.




### Copenhagen Tower Experiments, h=115 m

- Release: $SF_6$, no bouyancy, no momentum
- Roughness: suburbian conditions
- Used diffusion parameters: **Karlsruhe-Jülich and Mol**

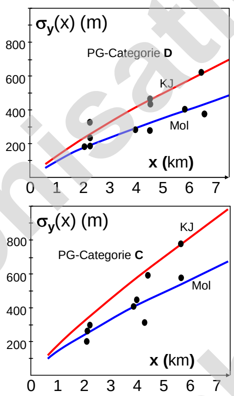
**Measured and calculated near ground tracer concentrations:**




**Compared with RODOS: all 9 data sets**

**Measured horizontal plume widths (sigma y)** for neutral and unstable conditions. Plume height =115 m.

**compared with KJ- and Mol sigma-y parameters**




### Kincaid Coal Fired Power Plant $h_{stack}$=187 m

- Release: $SF_6$, high bouyancy and momentum
- Roughness: rural conditions
- Used diffusion parameters: **Mol**

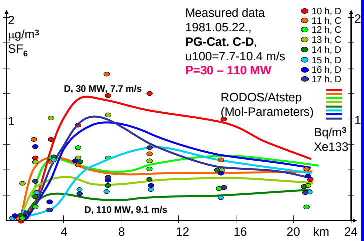
**Compared with RODOS: 17 hourly data sets**

**Measured and calculated tracer concentrations near ground:**

High Wind Speeds, Near Neutral Conditions, Varying Heat Releases:

Calculated rise of the hot plume reaches heights between 370 and 430 m within the first 2 km.

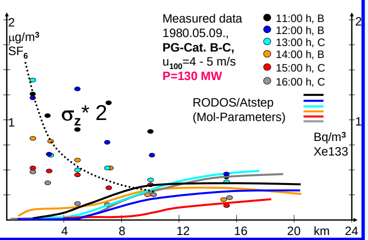
High ground concentrations are roughly correlated with low heat emissions and vice versa.




Low Wind Speeds, Convective Conditions, High Release of Heat:

The calculated rise of the hot plume reaches heights between 600 and 700 m within the first 2 km.

Ground concentrations are sensitive to the ratio $R=h/\sigma_z$, especially if R>3. The Gaussian factor $\exp(-0.5R^2)$ shows this. Either the near range $\sigma_z$ is too small here or plume rise is smaller than calculated.

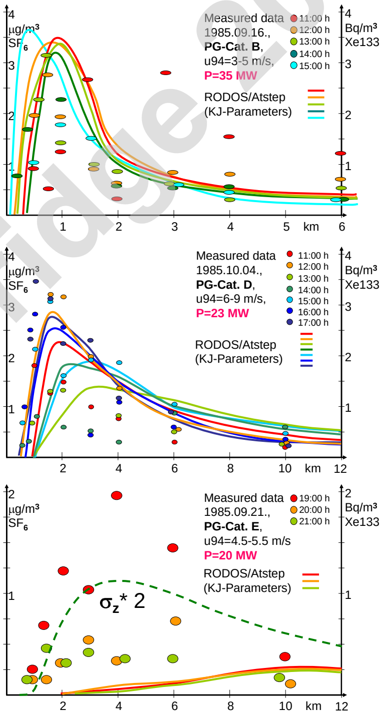



### Indianapolis Perry K Coal Fired Power Plant $h_{stack}$=84 m

- Release: $SF_6$, bouyancy and momentum
- Roughness: urban conditions
- Used diffusion parameters: **Karlsruhe-Jülich (KJ)**

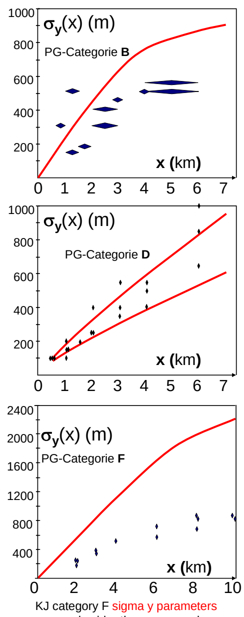
**Compared with RODOS: 60 hourly data sets**

**Measured and calculated tracer concentrations near ground:**




High sensitivity of near range concentrations with respect to the vertical plume width parameter sigma z

**Measured and calculated horizontal plume widths (sigma y)** for unstable, neutral, and stable conditions. Plume height > 200 m:




KJ category F sigma y parameters are much wider than measured

### Conclusions

- **Copenhagen:** All measured data (D and C categories) are well fit by RODOS / ATSTEP with both Mol and Karlsruhe-Jülich diffusion parameters.
- **Indianapolis:** In case of unstable and neutral conditions the calculated concentrations under the plume axis fit quite well to measured data. The same is true for horizontal plume widths which show satisfactory accordance with measured widths.

  In case of stable stratification and plume heights >150 m the Karlsruhe-Jülich $\sigma_z$ parameter is far too small and has to be multiplied by a factor of 2 to 3. Furthermore the calculated plumes (with KJ parameters) are wider by a factor of 2.
- **Kincaid:** Calculated concentrations under the plume axis fit more or less to measured data in case of neutral conditions with higher wind speeds (plume rise levels off). In case of unstable or stable stratification with lower wind speed and high thermal power releases plume rise is relatively strong and the Mol $\sigma_z$ parameters are too small in the near range and have to be multiplied by factors of 2 to 3 there.

HELMHOLTZ GEMEINSCHAFT

mit der Universität Karlsruhe verbunden im KIT Karlsruhe Institute of Technology