	General Characteristics	
1	**Abstract of Model Capabilities**	VDI Parts 1 and 2 are individual computer programs designed to model the dispersion of vapor plumes (positively and neutrally buoyant), and denser-than-air vapor releases, respectively. Part 2 may be used to model the dispersion of dense gases in any one of 25 different configurations of street canyons, buildings, or the intersection of basic geometric shapes. Part 2 provides the distance to the lower flammability limit or the distance to the transition point from dense gas to neutrally buoyant behavior. Part 1 predicts the vapor concentration and dose exposure as a function of time and distance from the source either for an initially buoyant release or using the initial conditions provided by Part 2 for a dense gas release. Each part may be run separately or together in the case of toxic vapor exposure by means of a combined program called STOER.
2	**Sponsor and/or Developing Organization**	Verein Deutscher Ingenieure (VDI) Kommission Reinhaltung der Luft D-4000 Düsseldorf, Deutschland
3	**Last Custodian/ Point of Contact**	Dr. Michael Schatzmann Meteorologisches Institut Universität Hamburg Bundesstra be 55 D-20146 Hamburg Germany 49-40-41235090 49-40-41173350 **(Fax)**
4	**Life-Cycle**	Part 1: Only a single version (version 1.0). Part 2: Version 4.0 (September 1992); Version 3.0 (July 1990); version 2.0 (December 1988).
5	**Model Description Summary**	VDI Guidelines Parts 1 and 2 are computerized methodologies for predicting the dispersion of a neutrally buoyant and dense gas release, respectively. Both programs are part of the safety study program for the German Administrative Regulation for the Ordinance on Industrial Accidents. Part 1: This program is a computerized implementation of the Gaussian plume equations for continuous ground-level or elevated releases. The release rate may be time-varying within specific prescribed constraints on variability. Furthermore, reflection of the plume off the mixing layer lower boundary is also modeled. Part 2: This program is a method for predicting the dispersion of denser-than-air gases based on empirical data obtained from wind tunnel studies for “instantaneous” and time-varying continuous releases into a boundary layer shear flow. The model is applicable both for the cases of level, unobstructed dispersion as well as more complex flow and turbulence structure due to the presence of downwind obstacles.
6	**Application Limitation**	Part 1: The model assumes pure reflections of the plume at ground level and the mixing layer. Volume sources are initially approximated as right parallelepipeds. The time dependency of the volume source is approximated by the superposition of the concentration distribution attributed to a series of instantaneous point sources. Part 2: All dense gas releases are assumed to be ground-level sources at a nominal ambient temperature of 15^{o}C whereas the neutrally buoyant model treats both ground-level and elevated with no assumption on ambient temperature. Heat transfer effects are not modeled in the code and the calculations assume a fully developed single-phase vapor cloud is given. Therefore, superheated flashing releases or vapor clouds containing suspended aerosol cannot be treated in a rigorous way but rather relies on the user to approximate these effects by means of initial cloud density and mass.
7	**Strengths/ Limitations**	**Strengths:** The dense gas model has the option of modeling the effect of the presence of obstacles to flow (e.g., street canyons, buildings, or the intersection of basic geometrical shapes for a total of 25 different configurations) on the subsequent downwind vapor dispersion. Provisions for modeling the dispersion from a line, area, and volumetric neutrally buoyant vapor source are available in the code. **Limitations:** The method used for modeling line, area, and volumetric neutrally buoyant vapor sources is not an accurate solution to the diffusion equation and can potentially incur significant errors in the subsequent downwind concentration estimates when the dimensions of the source are not much less than the downwind distance of interest. The dense gas program assumes no initial dilution of the vapor cloud (however the guidelines can be applied in the case of initial dilution). Furthermore, the dense gas model only gives endpoint results (distance either to the lower flammable limit for flammable gases or 1% of initial concentration for toxic gases) for receptors on the lee side of the specified obstacle configuration.
8	**Model References**	• Verein Deutscher Ingenieure, Handbuch 3783, Reinhaltung der Luft, Blatt 1, Mai 1987. • Verein Deutscher Ingenieure, Handbuch 3783, Reinhaltung der Luft, Blatt 2, Juli 1990.

9	**Input Data/Parameter Requirements**	Buoyant Plumes: Effective heat emission rate associated with a vapor plume elevated above ambient temperature, volumetric emission rate (kg/s) (may be specified as a function of time in tabular format), plume elevation, wind speed, stability (stable, neutral, or unstable temperature stratification), mixing layer height. Neutrally-Buoyant Releases: Volumetric emission rate (may be specified as a function of time in tabular format), dimensions of source, location/downwind length/height of buildings on the lee side of the source (all buildings are assumed to be parallelepipeds with infinite extent in the crosswind direction), characteristic width of a street canyon and mean building height of structures located on either side, wind speed, anemometer height, stability (stable, neutral, or unstable temperature stratification), mixing layer height. Dense Gas Releases: Mass release rate (may be specified as a function of time in tabular format), with associated release duration or total mass of vapor released ("instantaneously"), initial vapor density, initial vapor temperature, flammability limits (combustible vapor only), terrain classification.
10	**Output Summary**	• Positively and Neutrally Buoyant Releases: Vapor concentration at selected downwind distances and time following initiation of the release for average and worst case meteorological conditions. • Dense Gas Releases: Downwind distance to the lower flammable limit for worst-case and median turbulence conditions. Downwind distance to a vapor concentration level of 1% of the initial concentration (assumed to be 100%) for worst-case and median turbulence conditions. • It should be noted that worst-case and median release conditions are defined differently based on internal turbulence and stochastic variability for dense releases and the more familiar wind speed/stability combination for neutrally buoyant vapor emissions (see user guide for more details).
11	**Applications**	The VDI guidelines have been approved for use by the German federal government for use in industrial hazardous chemical release safety studies.
12	**User-Friendliness**	All input is entered either via an ASCII file where variable names are equivalenced to an associated numerical value, or interactively by means of typing responses to a text screen prompt. All online program instructions, variable names, diagnostics, and output for VDI Part 1 and STOER (Parts 1 and 2 combined) are in German only. Part 2 (dense gas) is available in both English and German. All code reference manual documentation is in both English and German.
13	**Hardware-Software Interface Constraints/ Requirements**	**Operating system:** MicroSoft DOS version 3.0 or higher **Disk space required:** Less than 2 MB. **Run execution time for typical problem (CPU or Real Time):** Several seconds maximum on an 80386 processor or higher **Programming language:** FORTRAN F77 **Interface with other codes:** None **Portability:** The program should be easily portable to any platform supporting a standard FORTRAN compiler.
14	**Operational Parameters**	**Error Diagnostics:** A large portion of the input requires a simple yes/no answer or an integer value which serves as a flag to the program to use a specific type of model for the calculations. Entering an incorrect response in these cases simply results in the program prompting the user to re-enter the value from screen input. There are also a limited number of fatal diagnostic messages (e.g., failure to specify the initial source emission rate) in the program. **Batch Mode Capability (several cases at once)**: Both Parts 1 and 2 as well as STOER can be run in batch mode. Part 2 has the option of specifying multiple problem sessions in a single input file whereas Part 1 requires an auxiliary batch file be written to run each individual problem set in succession.
15	**Surety Considerations**	**Quality Assurance** Unknown **Benchmark Runs (comparison with other codes)** Unknown **Comparison with Field Experiments**
15	**Surety Considerations**	Wind tunnel validation experiments have been carried out using field data from continuous release tests with methane (Burro and Maplin Sands experiments) and propane (TgV Hamburg and Maplin Sands experiments).
16	**Runtime Characteristics**	Maximum preparation time for a single release (assuming the analyst understands German when using Part 1 or STOER) is expected to take approximately 1 hour. Input for a simple steady-state release could be set up within several minutes.

Specific Characteristics		
Part A: Source Term Submodel Type		
A1	**Source Term Algorithm?**	__YES ✔ NO
Part B: Dispersion Submodel Type		
B1	**Gaussian**	**✔ Straight-line plume __Segmented plume __ Statistical plume __ Statistical puff**
Part C: Transport Submodel Type		
C2	**Deterministic**	Yes
C4	**Frame of Reference**	**✔ Eulerian __ Lagrangian __ Hybrid __ Eulerian-Lagrangian**
Part D: Fire Submodel Type (Not Applicable)		
Part E: Energetic Events Submodel Type (Not Applicable)		
Part F: Health Consequence Submodel Type		
F1	**For Chemical Consequence Assessment Models**	**Health effects: __ fatalities __ cancers __ latent cancers __ symptom onset** **Health criteria** **__ IDLH __ STEL __ TLV __ TWA** **__ ERPG __ TEEL __ AEGL __ WHO** **Zones with flammable limits: ✔ UFL ✔ LFL** **Blast overpressure regions:** **Fire radiant energy zones:** **Risk qualification:** **Concentration: __ single value __ time-history __ integrated dose** **Probits:**
Part G: Effects and Countermeasures Submodel Type (Not Available)		
Part H: Physical Features of Model		
H2	**Release Elevation**	**✔ ground ✔ roof**
H3	**Aerodynamic Effects from Buildings and Obstacles**	**✔ building wake ✔ cavity ✔ K-factors ✔ flow separation** **Building wake effects are estimated for 25 different configurations.**
H6	**Mixing Layger**	**___ trapping __ lofting ✔ reflection __ penetration** **__ inversion breakup fumigation __ temporal variability**
Part I: Model Input Requirements		
I1	**Radio(chemical) and Weapon Release Parameters**	**Release rate: ✔ Continuous ✔ Time dependent __ Instantaneous** **Release container characteristics: ✔ vapor temperature __ tank diameter** **__ tank height __ tank temperature __ tank pressure __ nozzle diameter** **__ pipe length** **Jet release: __ initial size __ shape** **__ concentration profile at end of jet affected zone** **Release dimensions: ✔ point ✔ line ✔ area** **Release elevation: ✔ ground ✔ roof ✔ stack**

Part J: Model Output Capabilities		
J1	**Hazard Zone**	Part 2 of the VDI guidelines is designed primarily for determination of downwind distance to the lower flammability limit.
J3	**Concentration Versus Time Plots**	INELVIZ (see J2 above) has a data base from which concentrations versus time can be obtained; however, time plots must be made by an external plotting program.
J4	**Tabular at Fixed Downwind Locations**	Yes
Part K: Model Usage Considerations (No Information Provided.)		