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Waste Tank Vapor Project: Tank Vapor Database Development

P. R. Seesing
M. B. Birn
K. L. Manke

September 1994

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

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Richland, Washington 99352

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Summary

The objective of the Tank Vapor Database (TVD) Development task in FY 1994 was to create a database to store, retrieve, and analyze data collected from the vapor phase of Hanford waste tanks. The data needed to be accessible over the Hanford Local Area Network to users at both Westinghouse Hanford Company (WHC) and Pacific Northwest Laboratory (PNL). The data were restricted to results published in cleared reports from the laboratories analyzing vapor samples. Emphasis was placed on ease of access and flexibility of data formatting and reporting mechanisms.

Because of time and budget constraints, a Rapid Application Development strategy was adopted by the database development team. Meetings were held with Jerry Osborne and Jim Huckaby from WHC to build a conceptual model of the ultimate scope and desired uses of the database. Also, a working list of functional requirements was developed. The focus for FY 1994 was creating the relational database that would provide the information necessary for some of the long-term capabilities envisioned in the conceptual model. A milestone was established to make this database available by September 30, 1994.

An extensive data modeling exercise was conducted to determine the scope of information contained in the database. WHC and PNL scientists and managers participated in the modeling sessions. During the sessions, a broad data model and dictionary were developed. These were later simplified into a final data model and dictionary for the first release of TVD. The models were reviewed by staff who maintain the Tank Characterization Database and the Tank Waste Information Network System for compatibility with the technical and informational features of these systems. In the long term, the TVD will retrieve data from and share data with both of these systems.

A SUN® Sparcstation 1000 was procured as the database file server. A multi-user relational database management system, Sybase®, was chosen to provide the basic data storage and retrieval capabilities. Two packages were chosen for the user interface to the database: DataPrism® and Business Objects™. DataPrism was chosen for its ability to be used without further customization with databases on the server and prototype databases developed on an IBM® personal computer. Business Objects was chosen for its customization features that simplify the interface with the database structures. Users will be able to use the interface that they find most friendly.

A prototype database was constructed to provide the Waste Tank Vapor Project's Toxicology task with summarized and detailed information presented at Vapor Conference 4 by WHC, PNL, Oak Ridge National Laboratory, and Oregon Graduate Institute. The prototype was used to develop a list of reported compounds, and the range of values for compounds reported by the analytical laboratories using different sample containers and analysis methodologies. The prototype allowed a panel of toxicology experts to identify carcinogens and compounds whose concentrations were within the reach of regulatory limits.

The database and user documentation for Release 1 of the TVD were made available for general access in September 1994, meeting the formal milestone. The amount of data in the database was limited because of the small number of published reports available at that time. In 1995, plans call for the database to continue to expand with information on up to 60 tanks as the results are published, and with supplemental information about toxicology and meteorological conditions. Other features envisioned in the conceptual model will be developed as user interest and funding permit.

Acknowledgments

No project happens in a vacuum. We, the authors of this report, would like to take this opportunity to thank those who helped make it possible:

- Steve Goheen for his support
- Jerry Osborne and Jim Huckaby for their vision and assistance
- Mike Story for his support in the early stages
- John Fruchter for his continued faith
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- TWINS staff for their technical support, loan of hardware, and continued assistance
- Mike Sherrill for his assistance with Business Objects
- Scientists and technicians who took the time to explain what data they wanted
- Bob Bryce, Rich Barchet, and Pat Hays, for helping to make this team possible.

Contents

Summary iii

Aknowledgments v

Contents vii

Trademarks Used vii

1.0 Introduction 1

2.0 Database Design 3

3.0 Database Hardware and Software Acquisition 5

4.0 Prototype Creation 7

5.0 Release 1.0 Implementation 9

Appendix A - Tank Vapor Database Conceptual Model A.1

Appendix B - Data Model 2.0 . . . . . B.1

Appendix C - Model 3.3 - TVD Release 1 . . . . . C.1

Appendix D - Data Dictionary - TVD Release 1 . . . . . D.1

Appendix E - Component Hardware List for Tank Vapor Database Server E.1

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1.0 Introduction

Westinghouse Hanford Company's (WHC) Health and Safety organization has sponsored Pacific Northwest Laboratory's (PNL)[a] Tank Vapor Program. The program began in 1992 by studying means of sampling and analyzing vapors from the headspace of Hanford's single- and double-shell tanks. In 1993, the program grew to include offsite personnel from Oregon Graduate Institute (OGI), Oak Ridge National Laboratory (ORNL), and Sandia National Laboratory (SNL) in the analysis phase as well as PNL's Analytical Laboratories staff. The information generated from these laboratories will be used by Hanford managers, chemists, and toxicologists to make key safety decisions and to aid ongoing study relating to tank characterization and remediation activities. The Tank Vapor Program is a multi-year effort, including extensive vapor sampling of every single- and double-shell waste tank.

In 1993, the WHC manager of the program, Jerry Osborne, requested that PNL develop extensive database capabilities to support the work being done by the Tank Vapor Program participants. The long-term goals for the Tank Vapor Database (TVD) were

- electronic storage of data and images
- data compatibility and comparability with existing characterization databases
- data availability to scientists, managers, and stakeholders
- flexibility for synthesis, analysis, and hypothesis
- data to drive tank behavioral models
- rapid notification of safety issues determined from the data.

In response to WHC's expressed desire to have a working system implemented by the end of FY 1994, a Rapid Application Development (RAD) methodology was developed and implemented. The goal of the RAD methodology was to create working prototypes of the system as soon as possible for customer review and comment. The final product is the result of the refinement of successive prototypes. One of the strengths of this approach is that it recognizes that requirements may change over the course of the development and that such changes are made in a controlled way.

Being able to interact with the prototypes, a user is better able to visualize the completed system sooner in the development cycle. The inevitable flurry of system change requests that follow Release 1 in traditional software development are identified during the development phase in the RAD method. The method also ensures that extensive hands-on testing of the product is performed, and that human factors and preferences are identified early in the development.

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From November to December 1993, a needs analysis was conducted with Jerry Osborne, Jim Huckaby (WHC), and the PNL task leaders for the Waste Tank Vapor Project, resulting in an initial set of user requirements. These requirements were summarized in a conceptual model that provides the high-level view of the desired system's capabilities. This model is presented in Appendix A.

The WHC program manager was very explicit in his desire to have the information be widely accessible over the Hanford Local Area Network (HLAN), and have a flexible and user-friendly interface. Existing PNL guidelines and configurations for client-server database systems and platforms were used to build the system. Another critical feature of the database from the customer's perspective was that it would contain only cleared results (not interim results or draft findings) and that all results would be identifiable with their source document.

Time and budget constraints in 1994 prevented the simultaneous development of all the features of the conceptual model. The decision was made to focus FY 1994 activities on the development of a relational database that stored analytical results. A milestone was established to make this database available using HLAN by September 30, 1994.

An extensive data modeling exercise was undertaken. Prototypes were created and tested on IBM® personal computers to fine-tune various sections of the data model. The core tables of the TVD were made available using HLAN in September 1994, meeting the formal milestone. The amount of data in the database was limited because of the small number of cleared reports available at that time.

In FY 1995, the database will continue to expand with information on up to 60 tanks as the results are cleared. Supplemental information about toxicology and meteorological conditions will be added. Other features envisioned in the conceptual model will be developed as user interest and funding permit.

2.0 Database Design

The database design process began in January 1994, with extensive interviews of the Waste Tank Vapor Project task leaders and analytical chemists. The goal was to identify a broad spectrum of information that would be useful in adding context to the quantitative results expected from vapor sample analysis. This information included sample event data, meteorological data, toxicology and general chemical data, quality assurance, and organization data.

Relational databases organize data as a set of tables, each entry in a table containing one or more related pieces of information. The two traditional tools for documenting the layout of this kind of database are data models (also known as Entity-Relationship diagrams) and the data dictionary. A data model was created to organize the information obtained during the individual interviews. This model represents a universe of information that the scientific and management community felt would be useful in understanding the results obtained by vapor analysis. This model is presented in Appendix B. A data dictionary was created to accompany the model.

The data model was presented at a meeting of the WHC and PNL managers and scientists involved. This meeting was a starting point for numerous discussions about the actual amount and type of information that would be stored in the database. The data model was revised to reflect the higher level of information that WHC wanted. The data model that was created at the conclusion of the discussions is shown in Appendix C. The data dictionary was also revised; it is presented in Appendix D.

Computer scientists who maintain the Tank Characterization Database (TCD) and the Tank Waste Information Network System (TWINS) also reviewed the data model and dictionary. This was important because the long-term strategy for the TVD involves exchanging data with TCD rather than storing the data a second time in the TVD. Also, the TVD will be a component of TWINS, which will provide a convenient mechanism for the wide accessibility of the data envisioned by Jerry Osborne. Compatibility and comparability with these two systems was ensured by these design reviews.

3.0 Database Hardware and Software Acquisition

As is appropriate to the RAD method, the decisions on hardware and software were driven more by functional criteria than by a formal market survey.

The choice of the SUN® Sparcstation 1000 as the database server was driven by the fact that it is the platform of choice for PNL system development projects. There is ample expertise in the operation and management of this machine in PNL's Information Systems and Services organization, and the platform is identical to that used for the TWINS database server (minimizing connectivity, compatibility, and support issues). The technical merits of this platform are discussed in the Automated Data Processing Acquisition and Implementation Plan presented in April 1994, as part of the procurement of this equipment, and available upon request. The component hardware list for the database server is presented in Appendix E.

The choice of Sybase® as the underlying database management system (DBMS) was driven by similar considerations. This product is used by TWINS and is preferred by PNL computer scientists because of its faster performance in data retrieval than the Oracle® DBMS used by TCD. A product known as Omni-SQL® Gateway will be procured in FY 1995 to provide connectivity between TVD and TCD. This product bridges the technical differences between the two underlying DBMS.

Almost 35 user interface software packages, also known as client-server software, were examined. Two packages were chosen for TVD development: DataPrism® and Business Objects™. DataPrism was chosen for its ability to be used without further customization with databases on the server and prototype databases developed on an IBM personal computer, and for its identical look and feel on Macintosh® and IBM personal computers. Business Objects was chosen for its customization features that simplify the interface with the database structures, and because of an existing Site license that makes it available at no additional cost to PNL users.

4.0 Prototype Creation

Prototypes allow developers and users to experiment with data storage and retrieval strategies in an environment where the system can be quickly modified. Also, prototypes allow development to begin in advance of the arrival of procured hardware and software for the formal database (which in this case took 6 months). Even though they are throw-away products, prototypes prove the workability and effectiveness of design options.

In April 1994, a prototype database was constructed on an IBM personal computer to provide the Waste Tank Vapor Project's Toxicology task with summarized and detailed information about sample job 6B as presented at Vapor Conference 4 by WHC, PNL, ORNL, and OGI. The prototype was used to develop a list of 160 compounds and the range of values reported for those compounds by the laboratories. Because each laboratory used different sample containers and analysis methodologies, this provided a good indication of consistency of findings. It allowed a panel of toxicology experts to identify carcinogens and compounds whose concentrations were within reach of regulatory limits.

From a database development perspective, the prototype served as a test of the user interface software as well as a chance to check the congruence of the data model with data as actually reported. It allowed the developers to experiment with various ways of representing the data, and to observe first-hand one of the practical uses of the data - toxicological review. The feedback gained from this process led to the establishment of the table of regulatory limits for the database. The exercise also identified the necessity of creating a chemical identification table that had all of the compounds identified.

5.0 Release 1.0 Implementation

The TVD users will have read-only access to the database; the TVD data administrators will validate and update the database. All data are assembled on an IBM personal computer and validated before insertion into the TVD. This may occur in two ways. Data may be identified by reading the cleared report and entering the data by hand using software created for that purpose. Alternatively, data may be received in electronic format from the laboratory and then converted electronically to the TVD format. In both cases, data are cross-checked with the paper copy of the cleared report to ensure accuracy.

To establish a connection to the TVD, please contact any of the authors. To be able to use TVD, you must have the following:

- 80386SX or better microcomputer
- Microsoft® Windows™ 3.1 or better
- a Transmission Control Protocol/Internet Protocol (TCP/IP) connection over a local or wide area network
- a copy of the user interface software and associated software libraries
- a user-id and password from PNL.

Instructions for running the user interface software may be found in the TVD User's Guide, available separately from the authors. The user's guide contains step-by-step instructions for logging in and out of the system, creating and running queries against the database, and formatting the query results using the interface's report writing capabilities.

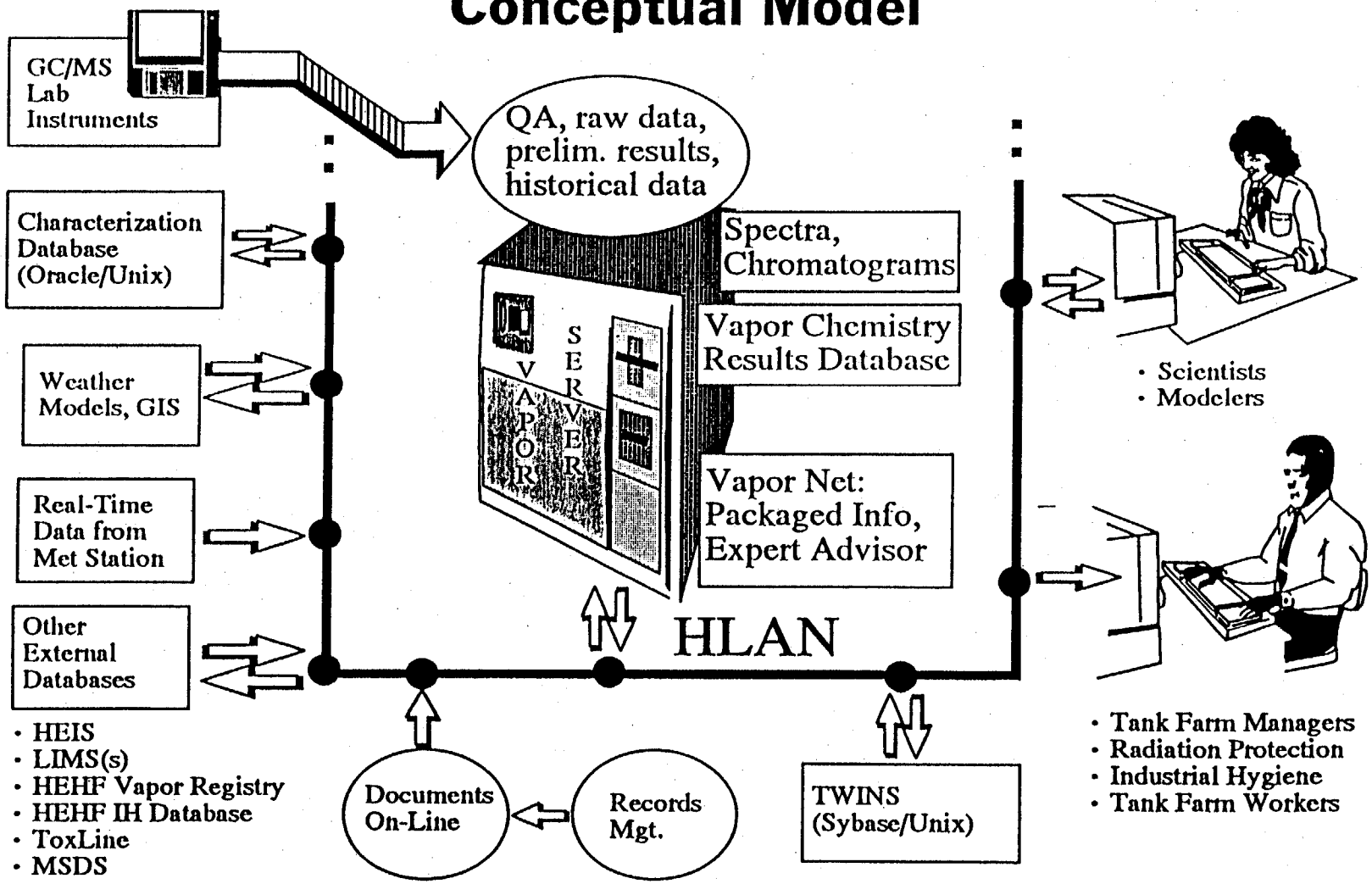
As of September 1994, only parts of the data for tank 241-C-103 are loaded, because this is the only data that has been cleared. The remainder of the data for this tank, and data for the other tanks, will be loaded as it is cleared by WHC or the analytical laboratory.

Supplemental data tables for general chemical information, meteorology, and toxicology will continue to be loaded and enhanced (funding permitting) as the information is identified. The database contents as well as its design have been driven by user comments. User suggestions are expected to increase as experience with the database grows. The architecture of the database has the flexibility to change data structures and incorporate new areas of information as needed. The final decision concerning the inclusion or exclusion of any data from the database will be made by the WHC program manager.

Appendix A

Tank Vapor Database Conceptual Model

Tank Vapor Database System
Conceptual Model

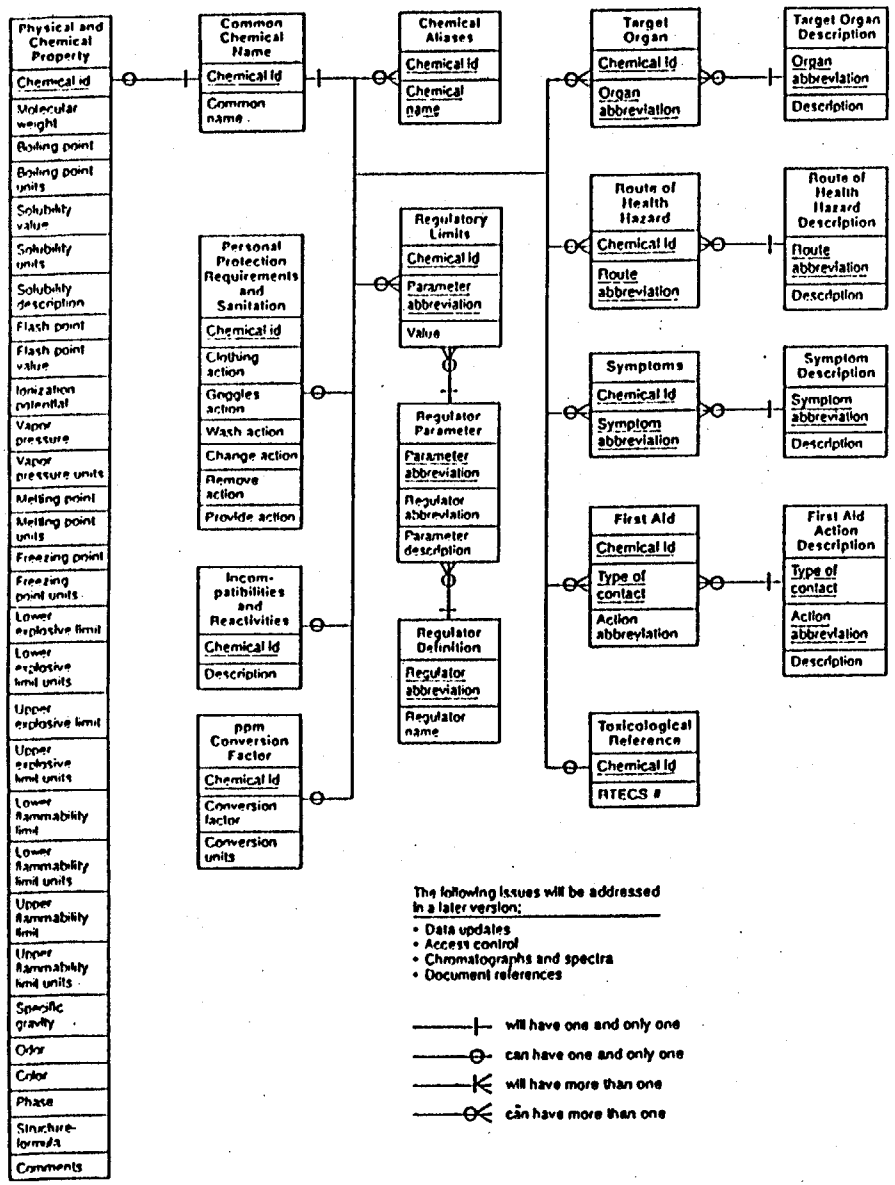


Version 1.4 - Tank Vapor Database Dream Team - 1/27/94

Appendix B

Data Model 2.0

Toxicology and General Chemical Data



The following issues will be addressed in a later version:

- Data updates
- Access control
- Chromatographs and spectra
- Document references

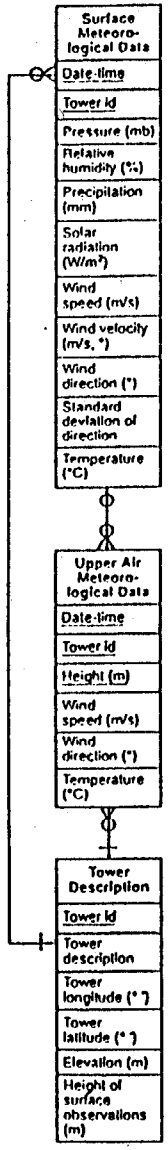
will have one and only one

can have one and only one

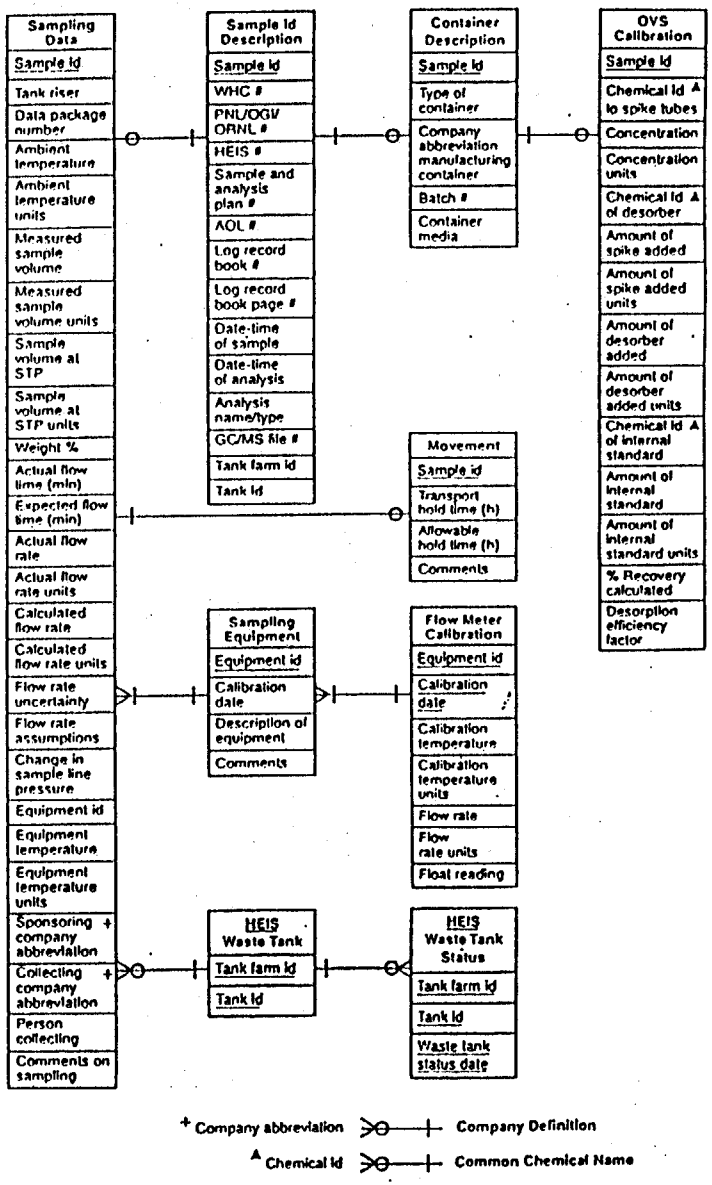
will have more than one

can have more than one

Meteorological Data

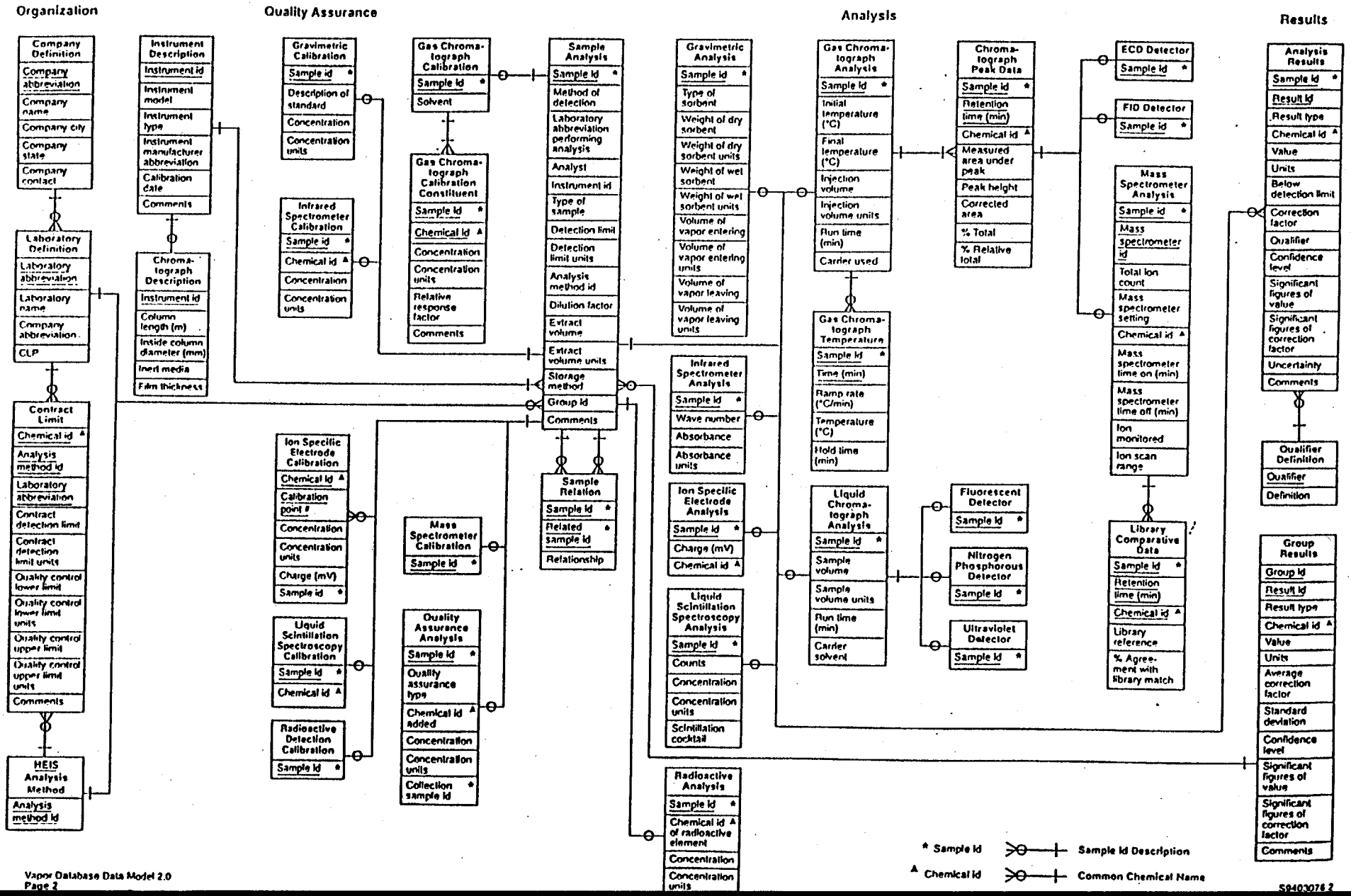


Sample Event Data



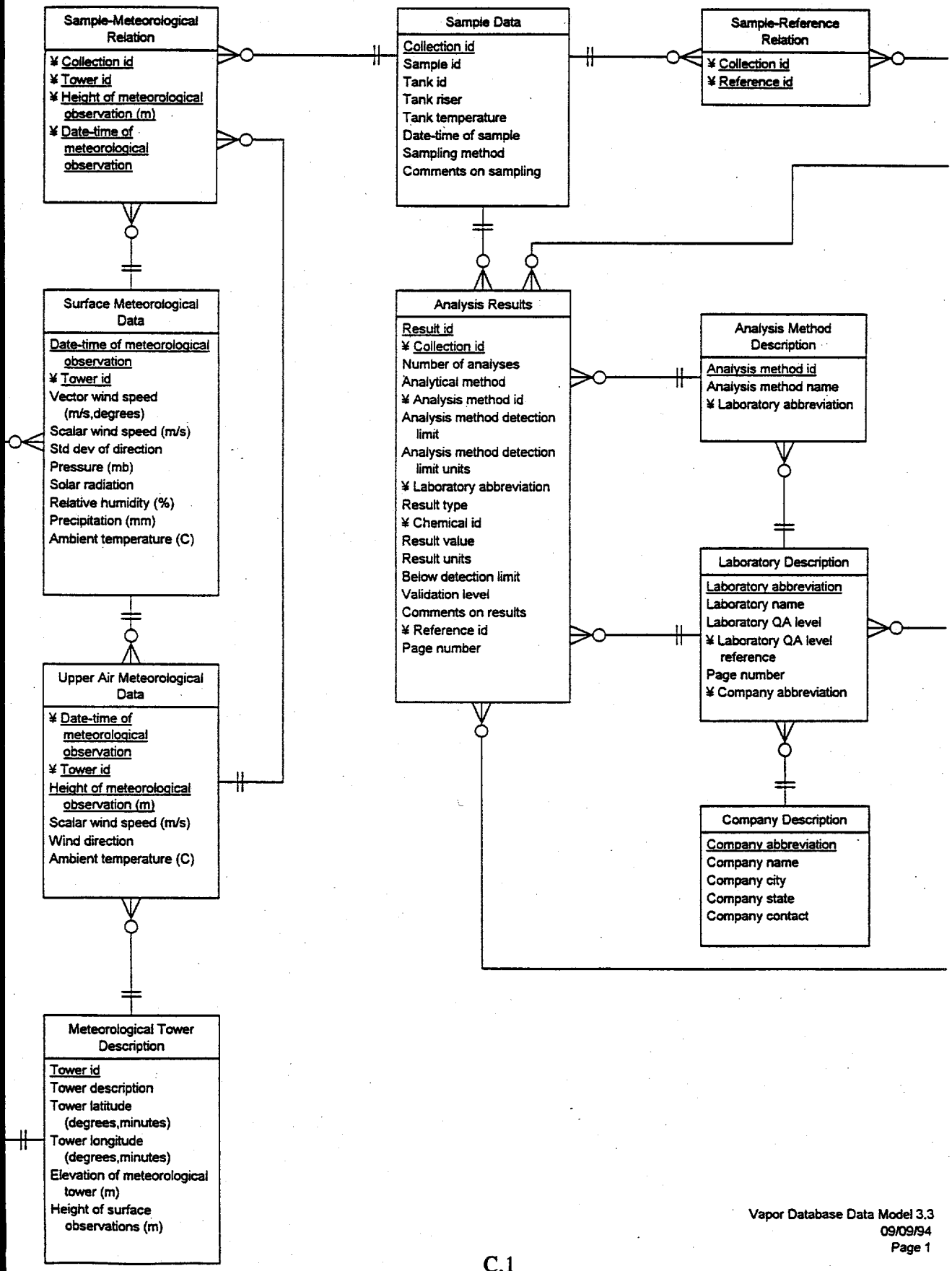
Vapor Database Data Model 2.0
Page 1

S9403076.1
3/29/94

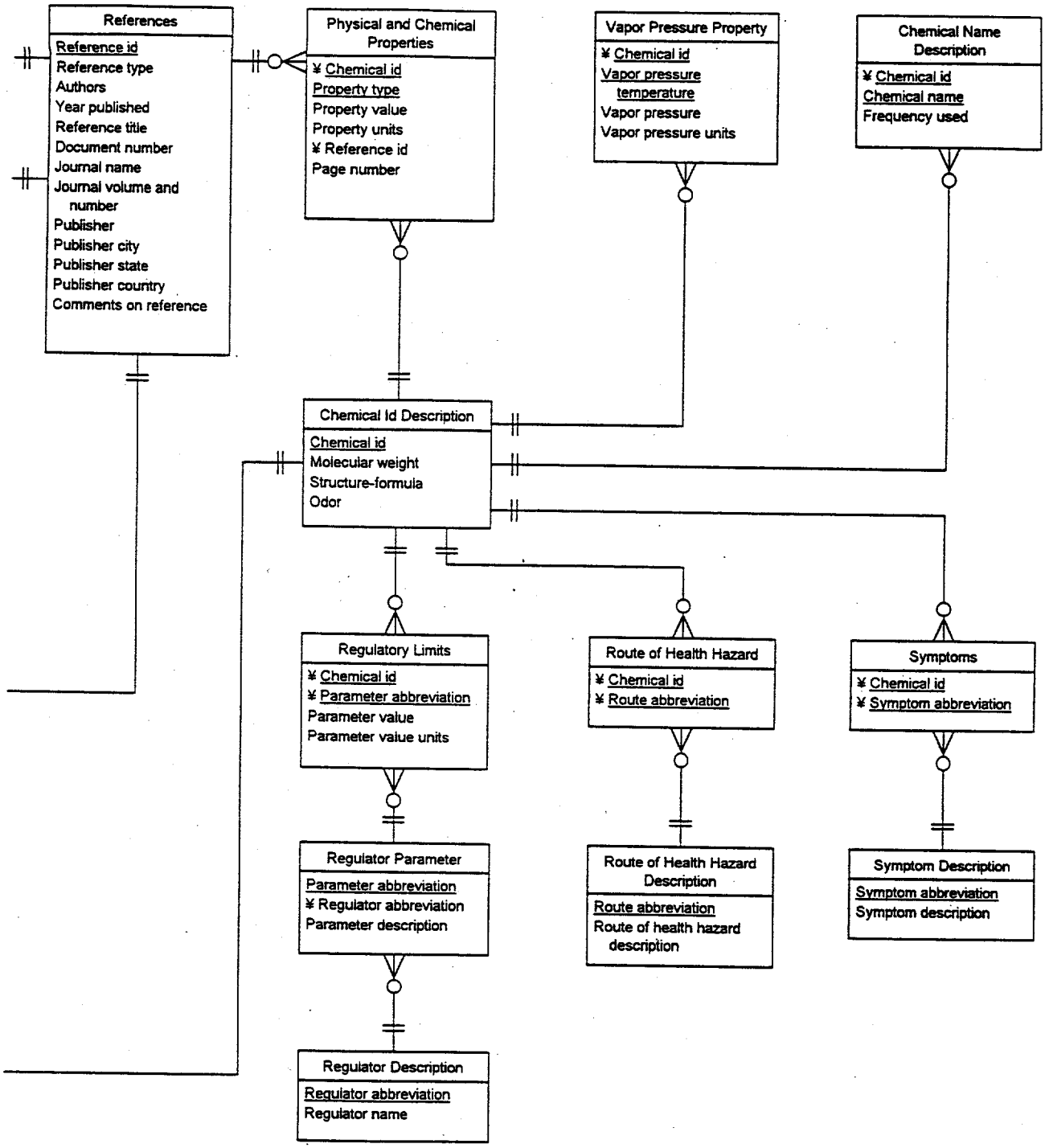

Organization
Quality Assurance
Analysis
Results
Company Definition
Company abbreviation
Company name
Company city
Company state
Company contact
Laboratory Definition
Laboratory abbreviation
Laboratory name
Company abbreviation
CLP
Contract Limit
Chemical id *
Analysis method id
Laboratory abbreviation
Contract detection limit
Contract detection limit units
Quality control lower limit
Quality control lower limit units
Quality control upper limit
Quality control upper limit units
Comments
HEIS Analysis Method
Analysis method id
Instrument Description
Instrument id
Instrument model
Instrument type
Instrument manufacturer abbreviation
Calibration date
Comments
Chromatograph Description
Instrument id
Column length (m)
Inside column diameter (mm)
Inert media
Film thickness
Gravimetric Calibration
Sample id *
Description of standard
Concentration
Concentration units
Infrared Spectrometer Calibration
Sample id *
Chemical id *
Concentration
Concentration units
Ion Specific Electrode Calibration
Chemical id *
Calibration point #
Concentration
Concentration units
Charge (mV)
Sample id *
Liquid Scintillation Spectroscopy Calibration
Sample id *
Chemical id *
Radioactive Detection Calibration
Sample id *
Gas Chromatograph Calibration
Sample id *
Solvent
Gas Chromatograph Calibration Constituent
Sample id *
Chemical id *
Concentration
Concentration units
Relative response factor
Comments
Mass Spectrometer Calibration
Sample id *
Quality Assurance Analysis
Sample id *
Quality assurance type
Chemical id added *
Concentration
Concentration units
Collection sample id *
Sample Analysis
Sample id *
Method of detection
Laboratory abbreviation performing analysis
Analyst
Instrument id
Type of sample
Detection limit
Detection limit units
Analysis method id
Dilution factor
Extract volume
Extract volume units
Storage method
Group id
Comments
Sample Relation
Sample id *
Related sample id *
Relationship
Gravimetric Analysis
Sample id *
Type of sorbent
Weight of dry sorbent
Weight of dry sorbent units
Weight of wet sorbent
Weight of wet sorbent units
Volume of vapor entering
Volume of vapor entering units
Volume of vapor leaving
Volume of vapor leaving units
Infrared Spectrometer Analysis
Sample id *
Wave number
Absorbance
Absorbance units
Ion Specific Electrode Analysis
Sample id *
Charge (mV)
Chemical id *
Liquid Scintillation Spectroscopy Analysis
Sample id *
Counts
Concentration
Concentration units
Scintillation cocktail
Radioactive Analysis
Sample id *
Chemical id * of radioactive element
Concentration
Concentration units
Gas Chromatograph Analysis
Sample id *
Initial temperature (°C)
Final temperature (°C)
Injection volume
Injection volume units
Run time (min)
Carrier used
Gas Chromatograph Temperature
Sample id *
Time (min)
Ramp rate (°C/min)
Temperature (°C)
Hold time (min)
Liquid Chromatograph Analysis
Sample id *
Sample volume
Sample volume units
Run time (min)
Carrier solvent
Chromatograph Peak Data
Sample id *
Retention time (min)
Chemical id *
Measured area under peak
Peak height
Corrected area
% Total
% Relative total
Fluorescent Detector
Sample id *
Nitrogen Phosphorous Detector
Sample id *
Ultraviolet Detector
Sample id *
ECD Detector
Sample id *
FID Detector
Sample id *
Mass Spectrometer Analysis
Sample id *
Mass spectrometer id
Total ion count
Mass spectrometer setting
Chemical id *
Mass spectrometer time on (min)
Mass spectrometer time off (min)
Ion monitored
Ion scan range
Library Comparative Data
Sample id *
Retention time (min)
Chemical id *
Library reference
% Agreement with library match
Analysis Results
Sample id *
Result id
Result type
Chemical id *
Value
Units
Below detection limit
Correction factor
Qualifier
Confidence level
Significant figures of value
Significant figures of correction factor
Uncertainty
Comments
Qualifier Definition
Qualifier
Definition
Group Results
Group id
Result id
Result type
Chemical id *
Value
Units
Average correction factor
Standard deviation
Confidence level
Significant figures of value
Significant figures of correction factor
Comments
* Sample id
Sample id Description
* Chemical id
Common Chemical Name
Vapor Database Data Model 2.0
Page 2
S9403076.2

Appendix C

Data Model 3.3 - TVD Release 1



Vapor Database Data Model 3.3
09/09/94
Page 1



Vapor Database Data Model 3.3
09/09/94
Page 2

Appendix D

Data Dictionary - TVD Release 1

Tank Vapor Chemistry Data Dictionary

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Ambient temperature	Temperature of the air around a meteorological tower (units are °C). The ambient temperature is reported as a 15-minute average	10°C	Surface Meteorological Data	No	Yes	float	
			Upper Air Meteorological Data	No	Yes	float	
Analysis method detection limit	Lowest amount a laboratory instrument can reliably detect	10.9	Analysis Results	No	Yes	float	
Analysis method detection limit units	Units for the lowest amount a laboratory instrument can reliably detect	mg/L	Analysis Results	No	Yes	char	10
Analysis method id	Code that identifies the methods, procedures, and/or protocols that describe how the results were obtained from a sample (a sample is defined as a discrete quantity of material collected for analysis)	54836	Analysis Method Description	Yes	No	char	15
			Analysis Results	No	Yes	char	15
Analysis method name	Description of the analysis method id; this includes the name of the methods, procedures, and/or protocols used to obtain the results	EPA SW-846, Thallium	Analysis Method Description	No	No	varchar	30
Analytical method	Primary instrumentation used to analyze a sample (a sample is defined as a discrete quantity of material collected for analysis). If the sample does not involve a specific instrument (for example, gravimetric analysis), then a general description is reported	GC/MS Ion chromatograph Gravimetric	Analysis Results	No	Yes	varchar	50

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Authors	People listed (by first and middle initial and last name) as writers. If authors are not listed, then the name of the company that produced the reference is reported. If a company is not listed, then the word "Anonymous" is reported	K. L. Manke, M. B. Birn, P. R. Seesing EPA Anonymous	References	No	No	varchar	255
Below detection limit	If a result was not reported because the value was below the detection limit of the instrumentation, then a Y is reported. If a result was above the the detection limit of the instrumentation, then a N is reported	Y N	Analysis Results	No	Yes	char	1
Chemical id	Chemical Abstract Services (CAS) number or appropriate code that uniquely identifies a chemical (a chemical is defined as an element or a compound, which includes radionuclides)	67-66-3 109-79-5	Analysis Results	No	No	char	15
			Chemical Id Description	Yes	No	char	15
			Chemical Name Description	Yes	No	char	15
			Physical and Chemical Properties	Yes	No	char	15
			Regulatory Limits	Yes	No	char	15
			Route of Health Hazard	Yes	No	char	15
			Symptoms	Yes	No	char	15
			Vapor Pressure Property	Yes	No	char	15
Chemical name	Name of a chemical (a chemical is defined as an element or a compound, which includes radionuclides)	Hexane Hexyl hydride	Chemical Name Description	Yes	No	varchar	240

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Collection id	System-generated code used to make each sample record unique. This code is internal to the database and should not be used for tracking purposes	System generated	Analysis Results	No	No	char	12
			Sample Data	Yes	No	char	12
			Sample-Meteorological Relation	Yes	No	char	12
			Sample-Reference Relation	Yes	No	char	12
Comments on reference	Any additional information that might help the user find the reference	This journal title changed to Kline's Vapor Studies in January 1994.	References	No	Yes	text	
Comments on results	Any concerns or unusual information about the results	Corrected for possible contamination attributed to painting in adjacent laboratory during trap analysis.	Analysis Results	No	Yes	text	
Comments on sampling	Any concerns or unusual information about collecting the sample (a sample is defined as a discrete quantity of material collected for analysis)	Valve connection was contaminated. The sampling amount is in question.	Sample Data	No	Yes	text	
Company abbreviation	Acronym of the company responsible for the overall management of the laboratory	WHC PNL	Company Description	Yes	No	char	6
			Laboratory Description	No	No	char	6
Company city	Name of city where the company responsible for the overall management of the laboratory is located (the onsite location is reported -- not the headquarters location, unless they are the same)	Richland	Company Description	No	Yes	varchar	30

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Company contact	Telephone number including area code of the main switchboard of the company responsible for the overall management of the laboratory (using this number is the first step in contacting the company; the switchboard operator should be able to provide other numbers and information)	509-376-7411 1-800-436-2437	Company Description	No	Yes	char	14
Company name	Name of company responsible for the overall management of the laboratory	Westinghouse Hanford Company	Company Description	No	No	varchar	255
Company state	Two-letter abbreviation of the state where the company responsible for the overall management of the laboratory is located (the onsite location is reported -- not the headquarters location, unless they are the same)	WA	Company Description	No	Yes	char	2
Date-time of meteorological observation	Date and time the meteorological data were reported at the meteorological tower	11-11-1993 12:56	Sample-Meteorological Relation	Yes	No	datetime	
			Surface Meteorological Data	Yes	No	datetime	
			Upper Air Meteorological Data	Yes	No	datetime	
Date-time of sample	Date and time the sample was taken (a sample is defined as a discrete quantity of material collected for analysis)	09-09-1993 11:44	Sample Data	No	No	datetime	
Document number	Code assigned by government agencies or government contractors to documents and correspondence they publish; the code is used for tracking purposes. This code includes revision numbers. This code does not include the UC category, which is used by the Office of Scientific and Technical Information	WHC-EP-0474 Rev 1 RL930008765	References	No	Yes	varchar	30

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Elevation of meteorological tower	Height above sea level of the base of a meteorological tower (units are meters)	233 m	Meteorological Tower Description	No	Yes	int	
Frequency used	The standard name is the name assigned to the Chemical Abstract Services number. A synonym is any other name associated with the chemical.	Standard name Synonym	Chemical Name Description	No	No	char	15
Height of meteorological observation	Vertical distance from the ground to where the surface meteorological measurement was taken (units are meters)	60 m	Sample-Meteorological Relation	Yes	No	int	
			Upper Air Meteorological Data	Yes	No	int	
Height of surface observations	Vertical distance from the base of a meteorological tower to the instruments measuring surface meteorological parameters were located (units are meters)	2 m	Meteorological Tower Description	No	Yes	int	
Journal name	Title of the journal. Subtitles are entered after a colon	MBKM Journal of Vapor Studies	References	No	Yes	varchar	255
Journal volume and number	For tracking purposes, a journal is often numbered by the publisher as if it was part of a large volume. Thus, the issues of a journal published in the same year are assigned the same volume number. The separate issues are assigned a consecutive number. For example, all 12 issues of NewsMonth published in 1987 would have the same volume number and would be numbered 1 through 12	12(1)	References	No	Yes	char	10
Laboratory abbreviation	Acronym of laboratory performing analyses	VAL	Analysis Method Description	No	Yes	char	6
			Analysis Results	No	Yes	char	6

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Laboratory abbreviation	Acronym of laboratory performing analyses	VAL	Laboratory Description	Yes	No	char	6
Laboratory name	Name of laboratory performing analyses	Vapor Analysis Laboratory	Laboratory Description	No	No	varchar	255
Laboratory QA level	Measure of the quality assurance of the laboratory performing the analyses (this is the company-defined quality assurance level)	3	Laboratory Description	No	Yes	char	5
Laboratory QA level reference	System-generated code that identifies the document where the the laboratory quality assurance level was cited. This code is internal to the database and should not be used for other purposes	System generated	Laboratory Description	No	Yes	char	12
Molecular weight	Sum of the naturally occuring isotopic atomic weights of all the atoms in a molecule (units are gram/mole)	27.0	Chemical Id Description	No	Yes	float	
Number of analyses	Number of analyses performed on one sample using the same type of primary instrumentation or primary method (a sample is defined as a discrete quantity of material collected for analysis) (for example, 12 analyses using the ion chromatograph were performed on one sample)	12	Analysis Results	No	Yes	int	
Odor	Description of the smell associated with a chemical	Pungent Unpleasant	Chemical Id Description	No	Yes	varchar	255
Page number	Page number or range of pages where the information was cited	877 1234-1255	Analysis Results	No	Yes	char	15
			Laboratory Description	No	Yes	char	15
			Physical and Chemical Properties	No	Yes	char	15

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Parameter abbreviation	Acronym of regulatory limit parameter	REL STEL PEL	Regulator Parameter	Yes	No	char	15
			Regulatory Limits	Yes	No	char	15
Parameter description	Name of regulatory limit parameter	Short-term limit Permissible exposure limit	Regulator Parameter	No	No	varchar	255
Parameter value	Value given for the regulatory parameter	1.0	Regulatory Limits	No	No	float	
Parameter value units	Units for the value of the regulatory parameter	ppm	Regulatory Limits	No	No	char	10
Precipitation	Amount of precipitation that has fallen in the past hour (units are millimeters)	2 mm	Surface Meteorological Data	No	Yes	float	
Pressure	Atmospheric pressure measured at a meteorological tower (units are millibars). The pressure is reported as a 15-minute average	1014 mb	Surface Meteorological Data	No	Yes	float	
Property type	A physical or chemical property of a chemical (a chemical is defined as an element or a compound, which includes radionuclides)	Melting point Odor threshold Lower flammability limit	Physical and Chemical Properties	Yes	No	varchar	30
Property units	Units used to report a physical or chemical property	°C ppm	Physical and Chemical Properties	No	No	char	10
Property value	Numeric value of a physical or chemical property of a chemical	2.0	Physical and Chemical Properties	No	No	float	
Publisher	Name of company that printed the reference	Pacific Northwest Laboratory Seesing & Grove, Inc.	References	No	Yes	varchar	255

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Publisher city	City where the publisher is located. The actual city should be reported; however, if this is not supplied, the city where the publisher's headquarters are located should be reported	Richland Washington, D.C.	References	No	Yes	varchar	30
Publisher country	Name of the country where the document was printed	Switzerland	References	No	Yes	varchar	30
Publisher state	Two-letter abbreviation of state where the publisher is located. The actual state should be reported; however, if this is not supplied, the state where the publisher's headquarters are located should be reported	WA	References	No	Yes	char	2
Reference id	System-generated code used to make each reference record unique. This code is internal to the database and should not be used for tracking documents	System generated	Analysis Results	No	No	char	12
			Physical and Chemical Properties	No	No	char	12
			References	Yes	No	char	12
			Sample-Reference Relation	Yes	No	char	12
Reference title	Title of the reference as it appears on the title page. Subtitles are entered after a colon. If one volume of a set is referenced, then the volume title and volume number should be reported as part of the title	Vapor Studies: Guidelines for a Changing Environment Vol. 5 Risk Communication	References	No	No	varchar	255
Reference type	Library classification of the reference. This is included to make finding the reference easier	Correspondence Report Journal	References	No	No	char	20

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Regulator abbreviation	Acronym of the organization that established the regulatory limit. This may include consensus exposure standard (CES) or other nonregulator abbreviations	OSHA EPA CES	Regulator Description	Yes	No	char	15
			Regulator Parameter	No	No	char	15
Regulator name	Name of organization that established the regulatory limit	National Institute of Occupational Safety and Health	Regulator Description	No	No	varchar	255
Relative humidity	Amount of water vapor in the air (units are %). The relative humidity is reported as a 15-minute average	30%	Surface Meteorological Data	No	Yes	float	
Result id	System-generated code to make each results record unique. This code is internal to the database and should not be used for tracking results	System generated	Analysis Results	Yes	No	char	12
Result type	Definition of the specific topic of the result value	Concentration %Water	Analysis Results	No	No	char	20
Result units	Units used to measure the result value	mg/L L %	Analysis Results	No	No	char	10
Result value	Number given for a result	13.55	Analysis Results	No	No	float	
Route abbreviation	Abbreviation of toxicologically important routes of entry into the human body. NIOSH only lists four possible routes	Inh Abs	Route of Health Hazard	Yes	No	char	4
			Route of Health Hazard Description	Yes	No	char	4
Route of health hazard description	Definition of the route of health hazard abbreviations	Inhalation Ingestion	Route of Health Hazard Description	No	No	varchar	255

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Sample id	Code assigned to a sample by the collecting organization (a sample is defined as a discrete quantity of material collected for analysis)	940811143205	Sample Data	No	Yes	varchar	45
Sampling method	Description of the type of container or general method used to collect a sample (a sample is defined as a discrete quantity of material collected for analysis)	SUMMA canister OVS tube	Sample Data	No	No	char	20
Scalar wind speed	Magnitude of average velocity vector (units are meter/second). The scalar wind speed is reported as a 15-minute average	2.3 m/s	Surface Meteorological Data	No	Yes	float	
			Upper Air Meteorological Data	No	Yes	float	
Solar radiation	Amount of direct short-wave electromagnetic radiation received at a meteorological tower (units are W/m²). The solar radiation is reported as a 1-hour average	75 W/m²	Surface Meteorological Data	No	Yes	float	
Std dev of direction	Amount of variation in wind direction (units are degrees)	2°	Surface Meteorological Data	No	Yes	float	
Structure-formula	Structural notation for a chemical	CH3CHO	Chemical Id Description	No	Yes	varchar	255
Symptom abbreviation	Abbreviation of a potential symptom of exposure to a chemical	Irrit eyes Weak Ftg	Symptom Description	Yes	No	char	15
			Symptoms	Yes	No	char	15
Symptom description	Description of acute (short term) symptoms caused by exposure to a chemical (chronic symptoms are not included in the database)	Giddiness Malaise	Symptom Description	No	No	varchar	255

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Tank id	Code that identifies each tank in a tank farm system	241-C-103 241-SY-101	Sample Data	No	Yes	char	15
Tank riser	Riser number on the waste tank from which the sample was taken (a sample is defined as a discrete quantity of material collected for analysis)	7	Sample Data	No	Yes	char	5
Tank temperature	Temperature inside the waste tank when the sample was taken (units are °C) (a sample is defined as a discrete quantity of material collected for analysis)	100°C	Sample Data	No	Yes	float	
Tower description	Location and/or type of meteorological tower	200 West Tower Portable C-Farm Tower	Meteorological Tower Description	No	No	varchar	30
Tower id	Code that identifies a meteorological tower where the data were collected	C01 HO9	Meteorological Tower Description	Yes	No	char	4
			Sample-Meteorological Relation	Yes	No	char	4
			Surface Meteorological Data	Yes	No	char	4
			Upper Air Meteorological Data	Yes	No	char	4
Tower latitude	Latitude of meteorological tower (units are degrees and minutes)	46°34'	Meteorological Tower Description	No	Yes	int	
Tower longitude	Longitude of meteorological tower (units are degrees and minutes)	119°36'	Meteorological Tower Description	No	Yes	int	

Entity Name	Description	Examples	Table Name	Key Field?	Can be Null?	Type/Length	
Validation level	The confidence level indicator associated with the quality of the data. Zero (0) indicates that the data has been entered only and no checks, verification, or validation has been performed. Three (3) indicates that the data has been sufficiently analyzed to be 95% confident in its value. In general, validation is defined as: 0 - Raw Data 1 - Verified/ Validated Data 2 - Systematic Error Correction Performed 3 - Statistical Error Correction Performed	0 1 2 3	Analysis Results	No	Yes	tinyint	
Vapor pressure	Partial pressure of the vapor in equilibrium over the solid or the liquid phase	630	Vapor Pressure Property	No	No	float	
Vapor pressure temperature	Temperature at which the vapor pressure was determined (units are °C)	25°C	Vapor Pressure Property	Yes	No	float	
Vapor pressure units	Units used to specify the vapor pressure for a chemical	mm Hg	Vapor Pressure Property	No	No	char	10
Vector wind speed	Vector speed of the wind, measuring both magnitude and direction (units are meters/second and degrees). The vector wind speed is reported as a 15-minute average	5 m/s 240°	Surface Meteorological Data	No	Yes	float	
Wind direction	Direction of wind at a specific level on a meteorological tower (units are degrees)	170°	Upper Air Meteorological Data	No	Yes	int	
Year published	Year the reference was published according to the title page	1994	References	No	No	char	4

Appendix E

Component Hardware List for Tank Vapor Database Server

Component Hardware List for Tank Vapor Database Server

Description	Units	Cost
SUN SS1000 2CPU 64 MB 60mh or greater North American power kit 4 x 535 MB system disk space network interface	1	$32,050
Solaris 2.3 Server Media Kit CD	1	$39
System board/additional for SUN SS1000	1	$8,131
64MB memory ECC expansion for SS1000	1	$3,015
6 x 2.1 GB GIGARAID disk storage system	1	$15,900
Six tape autoloader 4mm DAT tape stacker	1	$2,755
Cisco Crescendo FDDI SBus Adapter - Turbo	2	$2,780
Cisco WA-C301T SMARTNet	2	$280
VT420 Monitor	1	$365

Equipment subtotal		$64,911
Procurement and other service costs		$4,034

Total		$68,944

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