Agilent ChemStation Plus

February 2009

Specifications

General Description

This document provides specifications for Agilent ChemStore C/S and Agilent ChemStation Plus Security Pack, which are part of the Agilent ChemStation Plus family. With the Agilent ChemStation Plus family you need to purchase only the features you require. This can be the fully featured software package for the most advanced capabilities, or you can exclude features that you may not want now, and add them later as your needs change. The Agilent ChemStation Plus software package currently consists of the following modules:

Agilent ChemStation for GC, LC, LC/MSD, CE, and A/D systems
Instrument control, data evaluation systems. Detailed specifications are available in the Agilent ChemStation Specifications (Agilent publication number 5989-9795EN).

Agilent ChemStore C/S
Data organizing and storage module that provides a scalable in-process chromatographic data organization system for Agilent ChemStations (pages 2–20).

Agilent ChemStation Plus Security Pack
Support the requirements of 21 CFR Part 11. It uses a relational database based on the ChemStore C/S database for secure result data storage, data review and electronically signing off runs (pages 21–36).

Agilent Technologies

1. Agilent ChemStore C/S

What's New?

With revisions B.03.0x and B.04.0x users can benefit of new functionality in many areas as listed below.

Workflow

- Up to three configurable levels of approval linked to separate user privileges (see *Agilent ChemStation Plus Security Pack – Electronic signatures and password settings* on page 30)
- Optional locking of runs after approval to prevent them from further modification (see *Agilent ChemStation Plus Security Pack – Electronic signatures and password settings* on page 30)
- New chromatogram viewer providing dynamic zooming and rescaling capabilities (see *Agilent ChemStore C/S – User Interface* on page 15)
- Direct Read-access to ChemStation Method (see *Agilent ChemStation Plus Security Pack – Audit Trails and Change Documentation* on page 32)
- Variables in advanced queries for operator names and dates (see *Agilent ChemStore C/S – Working with Agilent ChemStore C/S* on page 8)
- New database field for area% results from ChemStation

Reporting

- Powerful custom calculator for advanced calculations, reporting and charting of calculation results, based on fully versioned calculation templates (see *ChemStore C/S – Working with Agilent ChemStore C/S, Custom calculations* on page 12)
- Optional peak performance calculation per-run or sequence line (see *ChemStore C/S – Reporting* on page 14)

Open system connectivity

- File-less LIMS interface (see *ChemStore C/S – LIMS Connectivity* on page 18)

Administration

- Email notification enhancements (see *Agilent ChemStation Plus Security Pack — E-Mail Notification* on page 34)
- Configurable command line access (see *ChemStation Plus Security Pack — User Management and Application Security* on page 25)
- Support for Windows XP Professional Workstation
- Support for Microsoft Vista and Microsoft Access 2007
- Support for Oracle 10g

Product Description

Agilent ChemStore C/S is a scalable in-process chromatographic database for Agilent ChemStations. It provides a means to easily organize, review and approve analytical data based on study and sample information. Agilent ChemStore C/S supports the users' data review process offering statistically result summaries, flexible control charts, cross-sample reports and documented data archiving and restoring. These services also aid users in doing on-going system suitability testing. The Agilent ChemStore C/S server database can be used as a single place for data storage for all analytical data including methods, sequences and the raw data. This data storage also satisfies the requirements for data handling in a regulated environment including the detailed requirements of the U.S. food and drug administration for electronic records and electronic signatures, known as 21 CFR Part 11.

Agilent ChemStore C/S is available in two different configurations:

- **Agilent ChemStore C/S standalone database**
  This provides a low cost, easy-to-use, entry-level database module which integrates with a single Agilent ChemStation workstation.Very limited maintenance support is required and any user with advanced knowledge of the Windows XP or Windows Vista operation system functionality for backup and administration can maintain it. This entry-level database module allows for storage of all raw and meta data in single database file to ensure full data integrity. The file format adheres to a common standard, which is used by many other applications, for example, MS Access.

- **Agilent ChemStore C/S server Oracle® database client/server system**
  This client/server system is based on an Oracle database running on a Windows 2000 server together with multiple Agilent ChemStations and/or Agilent ChemStore C/S review clients. It provides enhanced data security and data integrity, distributed processing, as well as the ability to store raw data, methods and sequence files

within the database. This configuration reflects best the regulatory needs for electronic records and ensures full data integrity and traceability.

Based on standard database features, Agilent ChemStore C/S offers functionality which focuses on the user's needs for fast, secure and traceable handling of chromatographic data:

- User-defined or automated transfer of selected data from the Agilent ChemStation into the Agilent ChemStore C/S database.
- Define, edit and manage "studies" as the underlying data storage format.
- Manage or restrict data access in studies by assigning study access only to authorized users.
- Create database queries interactively or execute predefined standard queries.
- Review entire sets of data across instruments and studies, that several sequences in a fast and easy manner.
- Create additional filters and selection criteria to produce adequate subsets of the study in order to best sort the data and optimize the performance.
- Complete audit traceability by individual log-ins and complete documentation within the database including authorization failures.
- Security check of all files that have been transferred over the network from the ChemStation application to the ChemStore database application and back. Whenever a corruption of the datafile is detected, the user receives an error message and the file is no longer available for modifications.
- Approve or reject runs after reviewing, following the rules for electronic signature.
- Ability to flag an arbitary set of samples for reprocessing, and to initiate batch reprocessing of those samples on any Agilent ChemStation in a C/S network.
- Custom fields—User specified additional information fields with each set of results ("run") to hold values not measured by the Agilent ChemStation (for example, weights, pH, etc.) that can be used for later queries, reports or charts.
- Flexibility in scaling and labeling control chart data.
- Simple user-defined calculations for control charts and reports.
- User-controlled fast and easy data export to other applications such as MS Excel®.
- Powerful and intuitive report generator based on MS Access runtime including most commonly used report templates.
- Architecture allows for off-line review. Can be installed as a data review client running on a separate PC without needing the Agilent ChemStation software.
- Data from non-Agilent chromatography systems may be included via the Agilent ChemStation AIA import capability.
- Agilent ChemStore C/S offers the possibility to start with an entry level solution, and to then upgrade when the data processing needs increase. Laboratories can easily upgrade from one or more entry-level standalone systems to an Agilent ChemStore C/S server Oracle database client/server system. Previously stored data in the entry-level databases can be easily migrated to the new server database. The user interface does not change, except that some additional items are available for administrators.
- A built-in archive/delete tool allows for easy data transfer to other disks and or media to free up database space while keeping a complete audit-trail of all archiving and delete operations.
- Automatic archiving based on a set of configurable archive queries for easy database maintenance and administration.
- Open system connectivity using XML (Extensible Markup Language) for easy data exchange with other applications.
- Advanced email notification feature (C/S only). See page 34 for details.

1. Agilent ChemStore C/S standalone

Hardware requirements

The following list shows the minimum hardware requirements for this application:

- 1.5 GHz Pentium IV
- 4 GByte of free hard disk space
- 512 MB RAM for single ChemStation instrument.
- 1 GB RAM for two or more instruments
- Display: 1280 × 1024, small fonts, true color (32 bit)
- For Windows Vista the minimum requirements for processor speed and memory are: 3.4 GHz Pentium IV, 1 GB RAM

Software requirements

The following list shows the minimum software requirements for this application:

- Windows Vista Business Ed. with Service Pack 1 or Windows XP Professional Service Pack 3
- Agilent ChemStation revision B.04.01 or later
- Microsoft Internet Explorer 7.0 or later
- A local or network printer must be installed and configured.

Hardware considerations

Disk space requirements depend on several factors, such as:

- number of runs and compounds,
- technique (3D data requires more disk space than 2D data)
- Agilent ChemStation report style
- the "Store in Addition" settings of the study to which the run is assigned, (see table 4 on page 7), and
- use of custom fields
- database backup requirements

Typical runs use approximately 10 KB for a short report with four peaks, and use up to 300 KB per run for an extended performance report with 20 peaks. Table 1 helps calculate the amount of hard disk space requirements. Additional information on this topic may be found in the *Agilent ChemStore C/S Installation* manual and the *Concepts Guide*.

Note:
The standalone database size is limited to 800 MB due to some strict size limitations in the underlying file format. To ensure optimum performance for later data review Agilent strongly recommends not to exceed this database size limit. Additional standalone databases can be created via the Agilent ChemStore C/S utility. If a larger single database is required, Agilent recommends that the client/server version of the product be purchased. The client/server database uses Oracle 10g as a management system, which allows for a much larger database.

Number of peaks	Agilent ChemStation report style	Run length (minutes)	Approximate size per run (KB)
4	short	6	10
4	short	30	40
4	extended performance	6	80
20	short	6	190
20	extended performance	6	300

Table 1
Client storage requirements for result only data storage

2. Agilent ChemStore server Oracle® database system

Client hardware requirements

The following list shows the minimum requirements for the ***client*** in a client/server installation.

- 1.5-GHz Pentium IV processor
- 4 GByte of free hard disk space
- 512 MB RAM for single ChemStation instrument.
- 1 GB RAM for two or more instruments
- Display: 1280 × 1024, small fonts, true color (32 bit)
- For Windows Vista operating systems the minimum require ments in respect to processor speed and memory are:
  3.4 GHz Pentium IV
  1 GB RAM

Software requirements

The following list shows the minimum software requirements for this application:

- Windows Vista Business Ed. with Service Pack 1 or Windows XP Profession Service Pack 3
- Microsoft TCP/IP protocol
- Microsoft Internet Explorer 7.0 or later
- Oracle 10g client version 10.2.0.4.0.
  (included with the ChemStore C/S server software)
- Agilent ChemStation version. B.04.01 or higher.
- A local or network printer must be installed and configured.

Server hardware requirements

Agilent has optimized the performance of a ChemStation Plus client/server system to an average of 30 "concurrent" Agilent ChemStation/Agilent ChemStore Review clients, where concurrent clients are defined as clients connected to the central ChemStore C/S data organization system, that actively either spool data to the database or perform interactive queries (review client). Due to the nature of the application the impact of data retrieval is higher as this requires direct access to the database, while during acquisition the spooler is able to buffer data, thus ensuring a secure transfer in case of a network failure, for example. So the optimum number of concurrent clients might vary depending on the work practice in the laboratory. Depending on the combination of 2D/3D instruments, a typical high-end configuration can thus grow to approximately 30 acquisition clients with a maximum of 90 instruments. It is therefore recommended to use a high speed multi processor system with sufficient RAM.

The minimum requirements for the ***server*** in a Client/Server installation are the following:

- 1.5 GHz Pentium IV processor
- 1 GB RAM
- RAID SCSI controller
- 6 disk drives - 36 GB or larger– 2 drives configured as a mirror set and 4 drives configured as a RAID-5 array
- Backup tape device
- Uninterruptable power supply (UPS)

Note:
The drive configuration yields one mirrored partition for the operating system and application software, and one large array for the database files.

Server hardware considerations

The hardware requirements of the Agilent ChemStore C/S server will

	Entry level	Standard level	Highend level
No. of concurrent review clients	1-5	1-15	> 15
Processor speed (GHz)	1	3	3
Number of processors	1	2	2
RAM (GB)	1	4	32
Number of RAID controllers	1	2	2
Disks for operating system	2 ×36 GB RAID 1	2 ×36 GB RAID 1 (Controller 1)	2 ×18 GB RAID 1 (Controller 1)
Disks for Oracle database	5 ×36 GB RAID 5 RAID 5	5 ×146 GB RAID 5 (Controller 2)	5 ×36 GB RAID 5, (Oracle Data, Contoller 2) 2 ×18 GB RAID 1 (Index Log Files, Rollback Segments, Controller 1)
Hot swappable drives	yes	yes	yes
Backup device	Ultrium tape drive	Ultrium tape drive	Ultrium tape drive
UPS	yes	yes	yes

Table 2
Recommended server configurations for Agilent ChemStore C/S

vary based on the size of the database selected at installation time and the number of concurrent connections (the number of active instruments acquiring samples to the database and Agilent ChemStore C/S review clients) and the backup requirements for the server database. Table 2 shows three recommended server configurations. In a very small networked installation with less than three clients and no need for advanced security using RAID, the ChemStore C/S Oracle database can also run on a high-end PC using Microsoft Windows 2003 server software as operating system.

Note:
Planning the server disk configuration is very important:
36 GByte (for small database) to 146 GByte (for large database) hard disk, RAID 5 configuration is recommended. Using a RAID 5 hard disk configuration (redundancy and striping) yields less free hard disk space than RAID 0 (no redundancy). For example, 3 disks of 9 GByte each using RAID 5 yields 18 GBytes while using RAID 0 yields 27 GByte. RAID 5 is recommended for maximum performance and protection of your data. For backup operation of the database, the required disk space must be duplicated, that is a 54 GByte RAID 5 configuration should have an additional 54 GByte of disk space available for database backup. When calculating server memory requirements, calculate 8 MB of additional memory for each Agilent ChemStore C/S client. For more details on setup and configuration of the server, please refer to the *Agilent ChemStore C/S Installation* manual.

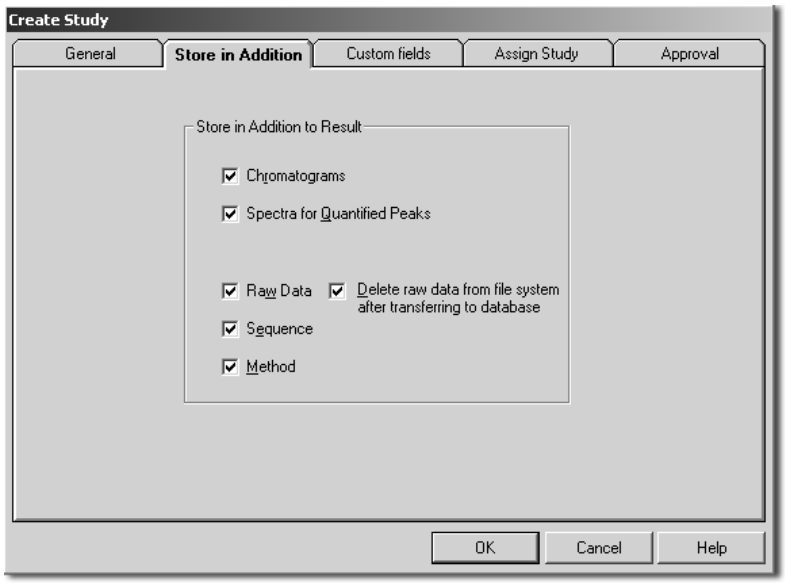

Figure 1
Study setup for full data integrity in the server database

Server software requirements

- Windows 2003 R2 server with Service Pack 2
- Microsoft Internet Explorer 7.o or later (for admin client only)
- Internet Information Server version 6 or greater (IIS is installed as part of the application server role.)
- Oracle 10g Standard or Enterprise Edition version 10.2.0.4.0.

Database size

The database size is selected at installation time and should be given careful consideration as this will affect the total number of runs which can be accessed online and the frequency of archive/dearchive operations. Archive with delete (to recover run space in the database) or dearchive operations (to access run data online). At installation time you can either select from the preconfigured databases configurations listed in table 3, or have a customized configuration. *Note:* The custom database configuration must be planned as a project with Agilent database consulting specialists prior to system

Database configuration	Approx. no. of runs	Database size
small	≤ 7500	4 GByte
medium	≤ 25000	10 GByte
large	≤ 80000	40 GByte

Table 3
Database configurations

installation. The size of the Agilent ChemStore C/S database is based on an Agilent ChemStore C/S system which has an average distribution of all Agilent ChemStation 2D and 3D techniques. Also, all *Store in Addition* checkboxes are enabled for all studies, as shown in figure 1. The space requirements for runs stored in the Agilent ChemStore C/S database will vary depending on your environment. A run is defined as a single set of results produced from a single sample acquisition or reprocessed by an Agilent ChemStation which has been transferred and stored in the Agilent ChemStore C/S database.

The actual amount of space consumed by each run in an Agilent ChemStore C/S database will vary depending on:

- the *Store in Addition to Result* settings of the study to which the run is assigned (table 4), and
- the technique and complexity (numbers of peaks, Agilent ChemStation reports, custom fields, and so on) of your chromatography for that run.
- For details on the size of raw data files by technique, please refer to table 5.

Supported Agilent ChemStation software

Agilent ChemStore C/S can be used with the following Agilent ChemStation software:

- Agilent ChemStation for gas chromatography, revision B.04.01 or later,
- Retention time locking software, add-on module for Agilent ChemStation for gas chromatography,
- Agilent ChemStation for liquid chromatography, revision B.04.01 or later or later,
- Agilent Method Scouting Wizard for method development systems
- Agilent ChemStation for capillary electrophoresis, revision B.04.01 or later,
- Agilent ChemStation for liquid chromatography mass selective detection, revision B.04.01 or later.
- Agilent ChemStation for analog signal acquisition, revision B.04.01 or later,
- Agilent ChemStation for capillary electrophoresis mass selective detection, revision B.04.01 or later,

Store in Addition	Description
Chromatograms	Stores all available chromatograms (from each detector and/or signal)
Spectra for quantified peaks	Stores spectra from all peaks that have been identified and quanti fied as compounds in the calibration table.
Raw data	Stores the acquired data in addition to the calculated result. *Note:* This setting has a significant effect on the amount of storage space required for each run in the ChemStore C/S database. For example ChemStation data which is created from 3D techniques such as a liquid chromatography diode array detector will require more storage space than a 2D technique such as gas chromatography.
Sequence	Stores the ChemStation sequence.
Method	Stores the ChemStation method

Table 4
***Store in Addition* study settings**

Technique	Average file size (kB)
2D GC/LC	50
3D LC	60
3D LC/MS	750
3D CE	600

Table 5
Average raw data file size by technique

1. Data transfer

The Agilent ChemStation Plus concept consists of different software components designed for the various tasks in the chromatographic laboratory. The Agilent ChemStation manages data acquisition and data analysis, and the Agilent ChemStore C/S database offers advanced data and result management along with additional sample information management such as data organization, advanced result calculations, result approval, and archiving. This concept allows a clear separation of result rework and advanced result review and offers unmatched data integrity and traceability by tracking the data history — Results in ChemStore can only be under review or after review completion, locked and pending for archival, while results in ChemStation are under rework. It is therefore very important to have a secure and documented data transfer between the software application. The specifications will offer a detailed outline of the data transfer including security measures for both directions. To further manifest this separation between rework and review, results can be locked from further modification when giving an approval.

From Agilent ChemStation to ChemStore database

Agilent ChemStore C/S offers two modes of data transfer from the Agilent ChemStation into the Agilent ChemStore C/S database –

- interactive mode and
- automated mode.

Figure 2 shows the interactive mode.

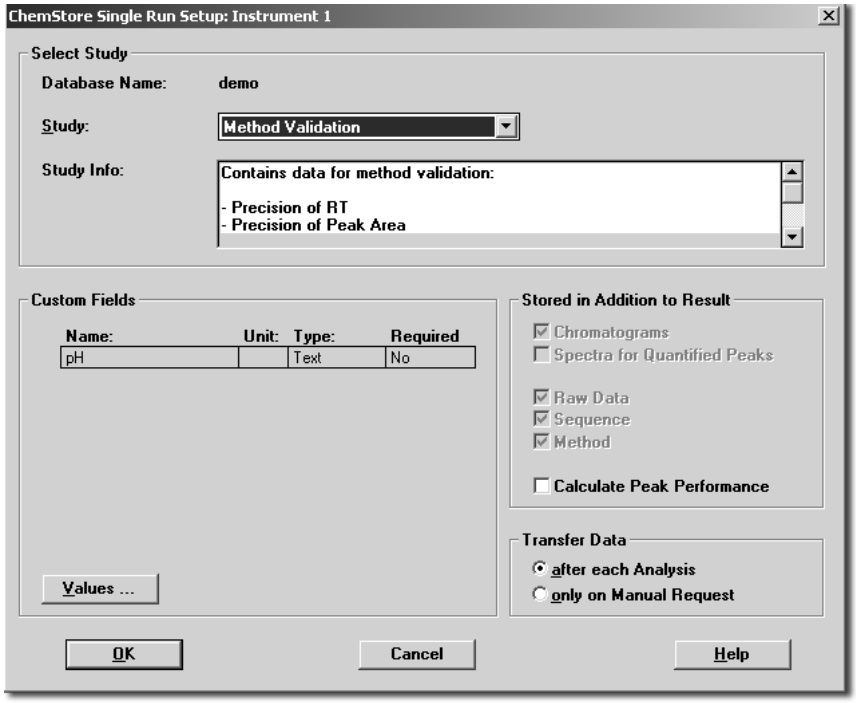

Figure 2
Data transfer setup screen in the Agilent ChemStation

Interactive mode
Users perform the transfer manually from the Agilent ChemStation menu item in "Data Analysis View" or use the batch review interface of the Agilent ChemStation. This mode of operation is useful for analysts who wish to perform a first pass data review from the Agilent ChemStation data analysis view before transferring the approved results to the database.

Automated mode
Results are transferred automatically to the database at the end of each run. This mode ensures that all analytical data are transferred into the Agilent ChemStore C/S server database and are protected from unauthorized modification. If the same sample injection is reanalyzed and then transferred, a new version of the result data is created, together with an entry in the audit trail of the Agilent ChemStore C/S database, thus ensuring a full history of the injection.

File security during data transfer
Each file that is transferred over the network from the ChemStation to the ChemStore database or back is protected with a hash value. The application software automatically calculates the hash value prior to any data transfer using a 24 character value based on the RSA Data Security, Inc, MD 5™ message digest algorithm. The hash value is stored with the data file. Whenever this data file is transferred over the network, e.g. for a reanalysis cycle, the same message algorithm calculates the hash value of

the current file and compares it with the stored value. Any difference is reported as an error and the data transfer is interrupted.

Assignment of studies and custom field information
Runs are stored in studies which form the top level hierarchical element of the Agilent ChemStore C/S database similar to a drawer in a cabinet. Study access is restricted to users that were explicitly granted the permission to access the data inside this study. Users must be assigned to a study in order to review study data or spool data into the study. The amount of result and meta data that is stored in the Agilent ChemStore C/S database is defined on a per study basis. For example, the transfer of a set of results may also include chromatograms and spectra, and the raw data, methods and sequence file used to produce those results.

Custom fields allow additional information or result fields to be linked to each set of results ("run"). They are used to store additional information that is not accessible from the Agilent ChemStation method or results, that is, information which may reflect other measurements (for example, LIMS ID, sample pH, patient weight, dosage, and so on) or may be used to organize the data (for example, the identification code of the test patient from whom a serum sample was obtained). These custom fields may be configured as "required" or "optional". For the former, a value must be specified before results can be transferred to the database or a sequence can be executed. Custom fields can also be used in later queries for reports, custom calculations or charts.

Study and custom field configuration
A custom field and its type are defined globally per database as shown in figure 3. The available field types are:
- True/False selection
- Configurable selection list
- Integer value
- Real value
- Text field
- Date or Date/Time

Custom fields need to be assigned to a study to activate them for use. As part of the study setup the user defines how the custom field is populated and whether it is a mandatory field or not. A custom field can be filled by a ChemStation function or manually. Manual fields can be flagged as "required" or a default value as well upper and lower limits can be specified.

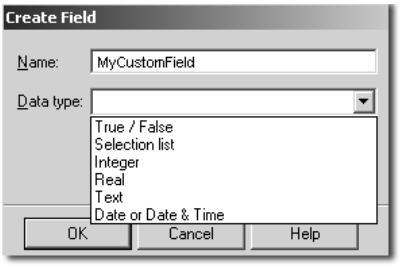

Figure 3
Creating a custom field

Custom field values are entered before the single sample or sequence acquisition:
- Single sample/manual operation: Study and custom field values are entered by a "single run" Agilent ChemStation menu item (figure 4).
- Sequence operation: Study and custom field values are specified per sequence line and and stored with the sequence.

Using Agilent ChemStore C/S data review capabilities, the lab manager or a quality control person can review data generated on multiple instruments throughout the lab. Samples can be approved, rejected, excluded or assigned for rework by the Agilent Chem-Station (see below *From database to the Agilent ChemStation*).

ChemStore spooler – Managing data transfer from Agilent ChemStation to Agilent ChemStore C/S
To ensure optimum performance of the Agilent ChemStation, a background spooler takes care of a secure result transfer from the Agilent ChemStation data into the Agilent ChemStore C/S database.

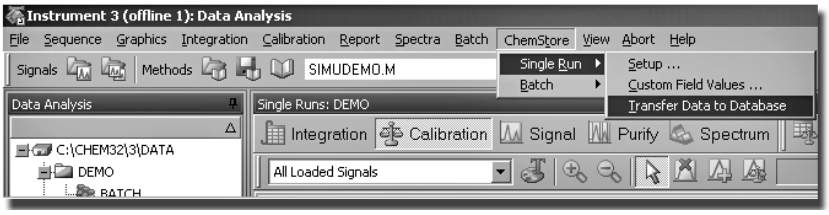

Figure 4
Data transfer setup screen in the Agilent ChemStation

This approach has several advantages, including

- releasing the Agilent ChemStation to go on with other tasks quickly while the transfer continues in the background and
- guarding against data loss in case the database insert operation fails or the network is down.

From database to the Agilent ChemStation

Runs which require further rework, for example manual integration, can be transferred from the database to the Agilent ChemStation. Agilent ChemStore C/S creates an Agilent ChemStation batch to ensure a consistent ease of operation. The setup for this batch submission is a two-step approach:

1. Create the batch request from the Agilent ChemStore C/S review client by marking the runs for transfer in the user interface. An authorized user configures the transfer details in an interactive pop-up window (figure 5). These include
   - assigning the run data to one or, in case of several runs, to more than one user for reanalysis on a per run basis,
   - optionally transferring the method with the data (including the choice between all versions of the method), and
   - entering a comment with each run transfer that will be displayed to the Agilent ChemStation operator.

2. Use the Agilent ChemStation *Load Batch from ChemStore* menu item to select the desired batch from the pool of pending Agilent ChemStore C/S batches to download the runs to the Agilent ChemStation. The operator then reviews the data in the ChemStation batch review and makes the necessary changes. After completion of the review the modifications can be transferred to the database as new result versions.

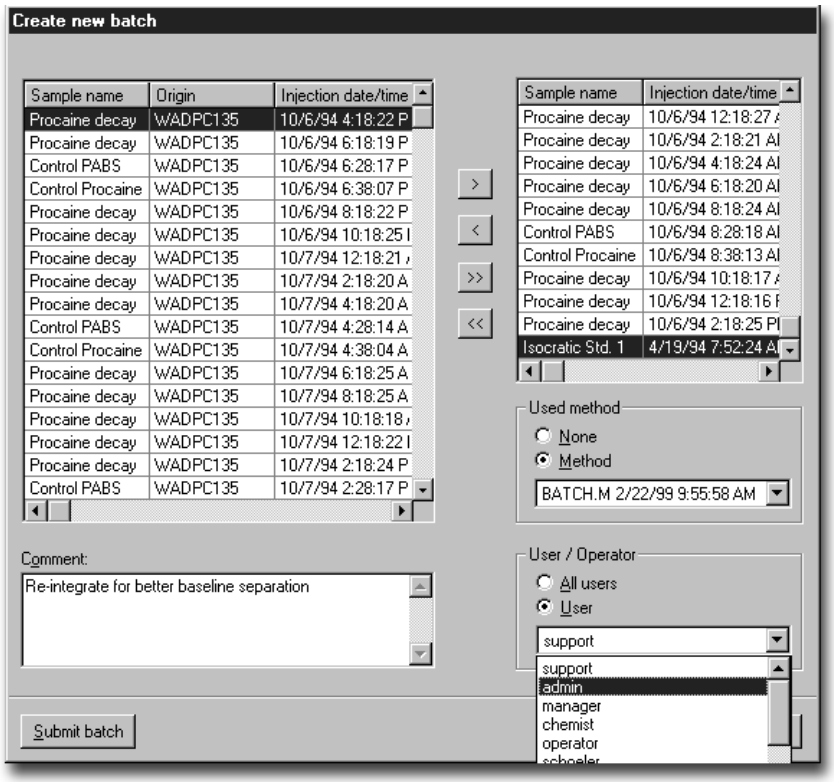

Figure 5
Batch setup for data transfer from database to the Agilent ChemStation

2. Task flow in the review client

Retrieve and review sample data

The ChemStore C/S review client provides two user interfaces for data review - the sample-centric *Sample* view and the compound-centric *Compound* view. Both views are further subdivided into a tabular display, with or without chromatograms and/or spectra, and a chart display for plotting sample- or compound-related data.

The task flow of Agilent ChemStore C/S is designed to support the laboratory's workflow and can be outlined as follows:

1. Select the database that contains the data you want to work with.
2. Extract the set of results you will work with. This is done via a database query and the results become the "current set of data".

3. Perform any of the following tasks, in any order:

- Review the results “by sample” or “by compound”. While reviewing the results, you may switch between any of several different data presentations (for example, a table, a chart, or plots of the chromatograms and or spectra). In addition, you may specify additional statistical computations to be done on the results and included in the tabular or graphical presentations.
- Generate a report on the data in the set of data. Any of a set of report templates may be used, and you may customize those templates according to your needs or create new ones.
- Export selected data. Data may be sent to an Excel 2007 “*.xls” file or to an application that supports cut-and-paste of the appropriate format.
- Execute custom calculations such as cross-run or cross-compound calculations or advanced statistical calculations. Predefined templates can be modified or new ones can be created. Modifications are stored as new template version. Calculation tables and charts of calculated values can be integrated into the report.
- Set up a “batch” by marking runs whose data and method are to be transferred back to the Agilent ChemStation for reanalysis.
- Filter or exclude any run in the current data set.
- Approve or reject runs based on your result review. Both steps follow the FDA requirements for electronic signatures.

The standard query builder of ChemStore C/S provides fast access to the commonly used database fields for fast and easy data retrieval. For more sophisticated queries the advanced query builder provides for access to all database fields, conditional query capabilities as well as the use of variables for the operator name (“currently logged on user”) and the date (for example “not older than 2 days”).

Performing statistics calculations

The user may optionally select to have statistical calculations performed on the (numerical) data which is being reviewed, as shown in figure 6. This can be achieved using summary statistics that calculates statistical values based on a single column of numerical values. The calculated values are:

- number
- minimum
- maximum
- sum
- mean
- variance
- standard deviation
- relative standard deviation

In addition, *Regression Statistics* can also be used to calculate curves and statistics of two numerical columns. Curve types include:

- linear
- quadratic
- cubic
- logarithmic
- exponential
- power

The curve parameters for the curves and the residuals will be calculated and displayed. Residual and curves can also be displayed in a chart.

Custom expressions

Simple Mathematical calculations may be performed on results using the built-in expression definition interface (figure 7).

This offers the basic expression functions (addition, subtraction, division and multiplication) plus the following functions:

- exponential
- natural logarithm
- logarithm
- square
- square root

	Biphenyl			
Statistics	Amount	RT	Area	Height
Count	15	15	15	15
Sum	0.14	38.57	4074.03	559.70
Minimum	0.00536	2.56547	142.49	25.44
Maximum	0.01701	2.58024	452.50	58.34
Mean	0.00955	2.57133	271.60	37.31
Standard Deviation	0.0045	0.0051	127.4384	13.9228
Rel. Std. Dev. (%)	47.2374	0.1968	46.9210	37.3131
Variance	0.0000	0.0000	16240.5492	193.8437

Figure 6
Summary statistics

Custom calculations

The ChemStore C/S custom calculator provides all means to develop custom calculations that cannot be done with the simple expression builder. The custom calculator user interface for development of calculation templates is shown in figure 8. Calculation templates are fully versioned. The modification of an existing calculation template is stored as a new template version. Only users with the appropriate permission have access to the custom calculator.

For a fast and easy template development the custom calculator is equipped with eight wizards:

- *Create Table* defines the data items for the calculation
- *Create Subtable* defines a sub-set of data
- *Insert Column* allows to define columns that are populated with calculation results and can be used in further calculations
- *Define Variable* allows to specify variables (fixed values or calculation results) that can be used in further calculations
- *IF condition* defines conditional values, for example for limit checking, resulting in a configurable result output, such as “pass” or “fail”.
- *Format* defines the number format and precision of data items for reporting
- *Transpose* allows to transpose a table or subtable

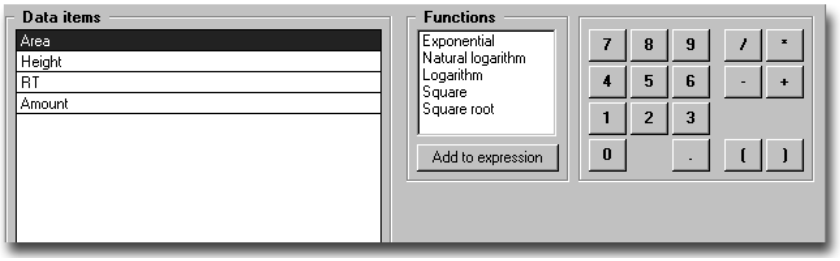

Figure 7
Setup of custom expressions

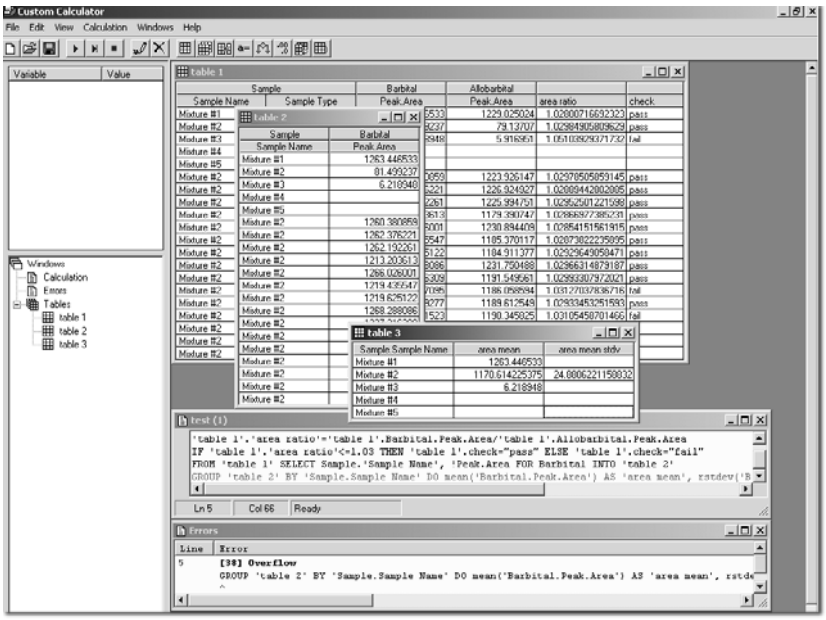

Figure 8
The custom calculator user interface

- *Group* allows to group by a specific data item and do statistical group calculations, such as
  – number of values (“count”),
  – maximum value,
  – mean value,
  – minimum value,
  – relative standard deviation,
  – standard deviation,
  – sum, and
  – variance.

The expression wizard (figure 9) is used for defining a calculation, which can be either an expression or condition. Calculations can be defined for all available columns or variables. It provides a set of arithmetical and statistical functions that can be used in conditions or expressions, these include:

- addition
- subtraction
- multiplication
- division
- absolute value
- count
- exponential
- logarithm
- natural logarithm
- mean value
- minimum
- maximum
- relative standard deviation
- square
- square root
- standard deviation
- sum
- variance

Multiple calculations can be defined within a single template based on any table or subtable.

All calculations are strictly column-based operations and easily allow any kind of cross-compound calculation, for example for the determination of relative retention times as required in some regulatory methods for confirmation of a successful identification or for calculating relative responses. The transpose wizard converts a table for doing cross-run calculations such as the comparison of results to a reference run. The group wizard provides for the ability of grouping a set of results by criteria

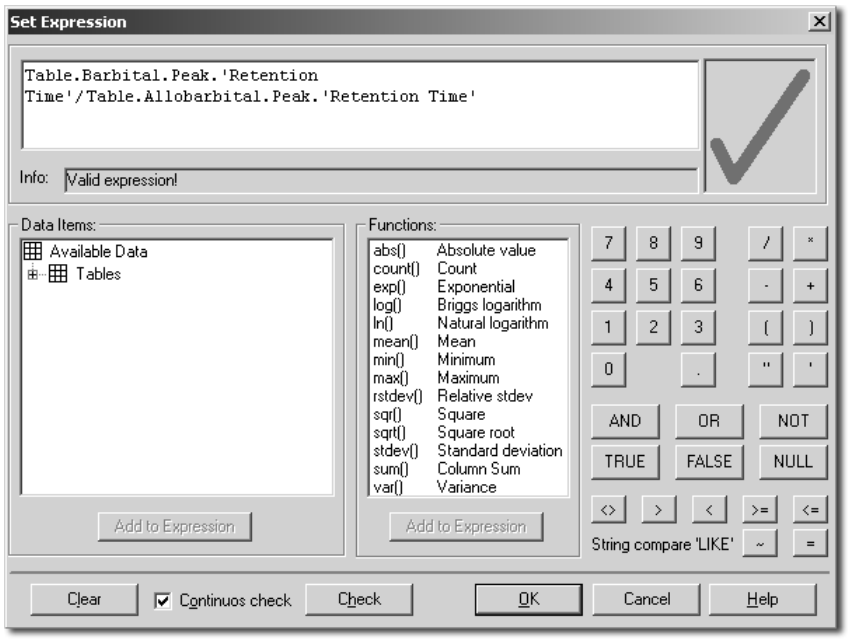

Figure 9
The expression builder of the custom calculator

stored in any other database field including custom fields. Groups of data can be used in statistical calculations, where the results may serve as a data source for further calculations. The IF condition wizard integrates with the expression builder and can filter result data based on virtually any condition. The output can be reported according to the specific laboratory or regulatory requirements, for example for limit checking – a sample result lying outside of a specified interval can be flagged as "out of spec.".

During the development the custom calculation is documented in a scripting window as shown in figure 8. This protocol is stored in the database as the calculation template. Each new version of a template is stored with version information. Optionally it can be included in the report to fully document the calculation.

Any part of the calculation or the complete template can be tested on sample data obtained by a database query. Any error or inconsistency is identified and documented in the error window. The related calculation piece is highlighted in the protocol for convenient and simple troubleshooting.

Calculation result tables as well as charted calculation results can be integrated into ChemStore reports. The user may choose whether to base a report on the latest version of a calculation or any earlier one. The reporting capabilities of ChemStore C/S are outlined in the following section.

Agilent ChemStore C/S — Reporting

Agilent ChemStore C/S offers a powerful report generator enabling users to easily create and generate final summary reports. The preview function helps to interactively develop the desired report without requiring test printouts. Agilent ChemStore C/S comes with a set of built-in templates to cover the most common needs for summary reporting. These templates can be used as a starting point to build your own customized reports.

Following is a list of built-in reports

- *Analysis Results* reports.
- *Audit Trails* reports
- *Compound Amounts* reports for individual results.
- *Instrument and Run* reports
- *Peak Details* reports
- *Kinetic Decay* reports.
- *Sample Summary* reports with numeric tables of the result information.
- *Sequence summary* report—a complete report for GMP requirements including summary statistics, graphics of chromatograms and spectra and result charts with control limits for each compound type grouped by the sample type.
- *System Suitability* summary reports including statistics over replicate injections.

The following are key customizable features of the reporting

- display of the selection criteria of the query,
- display of all custom calculations that have been used in the data section of the report
- an overall report header displayed on each page that allows to include graphic items such as a company logo,
- table information,
- configurable table contents and table header.
- fonts and font attributes,
- individual sections with additional individual headers containing data tables, chromatogram and spectra (if available from a diode array detector) or data charts,
- individual page breaks,
- additional sorting criteria within one data section to group data logically, for example, around a vial number, a sample type or any other item that the user requires,
- restriction capabilities to focus on an adequate subset of the data, that is, one peak within a chromatogram, and
- statistical calculations selected interactively at any time during the data review from the ChemStore C/S user interface.
- inclusion of custom calculation result tables, charts of calculated values and full documentation of the custom calculations, including calculation formula and calculation errors.

The ChemStore C/S application offers an additional functionality to print the current view. This function gives access to an immediate printout of the actual screen including all graphics without any formatting or configuration tasks.

For system suitability reports the calculation of system suitability parameters can be triggered independently of the ChemStation method during sample or sequence setup by enabling the "Calculate Peak Performance" checkmark per run or sequence line (see figure 2).

Agilent ChemStore C/S — Data Export into Other Applications

Agilent ChemStore C/S allows an easy export of selected database information (selection by records and data fields) to third party applications (notably MS Excel). The user has control over which fields are included and in which order. This can be done based on queries or reports exporting data into the native file format. Agilent ChemStore C/S also offers clipboard cut-and-paste for both tabular and graphical data (figure 10). Report outputs can be in a file format allowing convenient publishing of reports, for example, HTML for internet and intranet publishing.

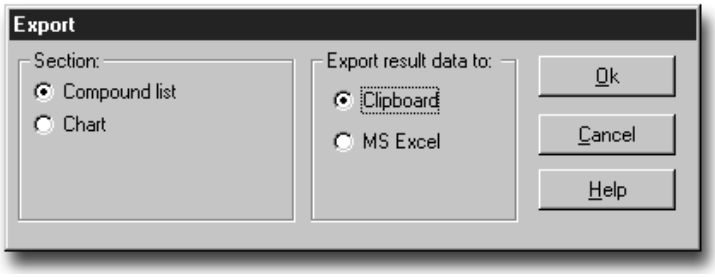

Figure 10
Interactive data export from Agilent ChemStore C/S into other applications

ChemStore C/S allows printing in the following file formats:

- HTML format for review with an Internet browser (excluding graphics).
- CSV format for spreadsheet applications
- XML format as generic file-interface (excluding graphics)

Agilent ChemStore C/S — User Interface

The Agilent ChemStore C/S review client offers the user two main "toolkits": data review and database administration. The latter will be described in the next section.

Sample and compound review

Within the data review toolkit, the user has a choice of whether to see data organized by analysis (also referred to as "run" or "sample") or by compound. In the table layout view data is displayed in configurable tables, either sample- or compound-centric.

Chromatogram/spectrum presentation

In the review layout view, the display area can contain both graphics and a table. The details differ for sample and compound review. The chromatogram viewer provides for dynamic zooming and rescaling capabilities, allowing a detailed inspection of the baseline to judge whether any rework of the integration is required.

General chart presentation

In the chart layout view the chart presentation is available only if no summary or regression statistics are in use. If regression statistics are being calculated, the regression chart and residual chart presentations replace it. Figure 11 is an example of a chart contained in the display area.

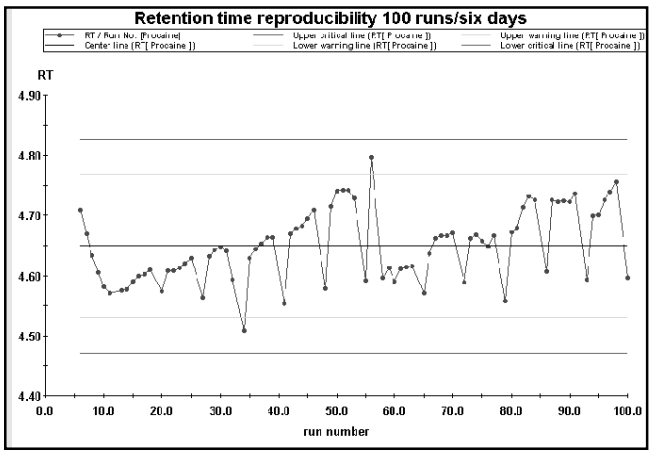

Figure 11
Chart for retention time reproducibility with warning and critical limits

Agilent ChemStore C/S — Security

Data acquisition, data analysis and data review are password-protected. Each user must have a valid user-id and a password to log on to the application, as shown in figure 12. To be able to transfer data to the database the user must be logged on to the database. User validation is done on a per database level and always requires to enter a user name and a password. Permissions for several tasks like approval or archival of runs, creation of custom fields, report templates, calculation templates or studies can be assigned to each individual user. Four user group templates for permission rights are supplied with the review client. They can be used as a starting point for the assignment of the permissions. Note that users and their security permissions are configured separately for each Agilent ChemStore C/S database. Users and their permissions can be imported from an existing database during creation of a new standalone database. In a client/server environment users are centrally managed in the Oracle database.

Electronic signatures and password security

Agilent ChemStore C/S uses electronic signatures based on the application User-ID/password combination to uniquely identify the users and their signatures. In order to keep the password unique to the individual user an additional security function is implemented to periodically check and revise passwords, and apply the company's password policy.

Minimum length is the minimum acceptable length (in characters) of a password. *Password validity* is the length of time (in days) over which the password remains valid. *Minimum password recycle* is the minimum number of new, unique passwords that a user must use before a password can be used again.

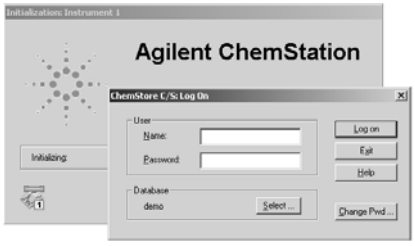

Figure 12
Password protection of the application software

Agilent ChemStore C/S — Database Administration, Backup and Recovery

Database administration

The review client provides the graphical user interface (GUI) through which the user can accomplish the following administrative tasks. Although the capabilities of the entry-level and client/server versions are to some extent different, the GUI is identical.

- Create a new database–(entry level database only),
- Compact (defragment) a data base–(entry level database only),
- Create or modify a study or custom fields,
- Administer system settings,
- Administer users and security,
- Manual or automatic archive, delete and de-archive data (server-only),
- Assign studies to users,
- Email notification for example on security violations (server-only).

The client/server version offers supplementary tools for administrators in the *Admin Client* to perform proper maintenance of the server database, archive/dearchive or archive/delete functions and other setup tasks. The Agilent ChemStore C/S *Admin Client* is a web-based application that can be run from any PC on the network. The *Admin Client* performs the following main tasks on the server database using a service running on the server.

- Schedule archive, dearchive and delete operations.
- Modify scheduled operations.
- View reports detailing pending operations.
- Review archive and dearchive history.
- View information about archives, runs and other objects, including a list of all runs in the archive unit.
- Execute archive, dearchive and delete operations immediately.
- Keep an audit trail of all archive and archive delete operations.
- Add and modify database connections to offer connection to a second Oracle database.

Database backup and recovery

One of the most important IT routines is the implementation of a Backup and Restore concept. Backups and – equally as important – the ability to restore a backup are important tasks in order to protect business data and laboratory investments.

Agilent Technologies can provide assistance in creating, implementing and testing a ChemStore C/S Server Backup and Restore strategy. This strategy should ideally be planned before the implementation but Agilent offers both, a service prior to the installation as well as a post implementation service.

For this purpose a ChemStore C/S Backup & Recovery strategy paper has been developed. With this strategy paper and by working with a customer's ChemStore C/S administrator Agilent provides a consulting service to plan and implement the right backup and recovery strategy for your business.

With a working knowledge of implementing solutions Agilent uses software from Symantec called Veritas Backup Exec Agent for Oracle™ and BrigthStor ® Arcserve® with Agent for Oracle, or Recovery Manager RMAN® from Oracle®.

Agilent ChemStore C/S — Archiving Data

The client-server version provides for manual or automatic archiving of runs present in the database to a separate file on disk or tape.

Manual archiving

Manual archiving is done from the "Archive/Delete" view in the ChemStore C/S review client and is based on the selected data set. Manual archiving requires the user to have the permission for archival. Individual runs or the whole set of runs are marked interactively for archival. These runs are then scheduled for the next archival operation on the server.

Automatic archival

An administrator with archival permission can set up a list of individual archive queries for automatic archiving, which are executed at predefined time intervals. Each custom query is put together from a set of criteria, including for example, injection time, sample name, instrument name, operator name, sequence name, method name, study name, custom field values, approval status and so on (figure 13). The available operands depend on the data category (text, numeric values, date) including wildcards and relative values (for example, runs "older than x days"). For performance reasons the number of clauses that can be defined for automated archival is restricted to 10.

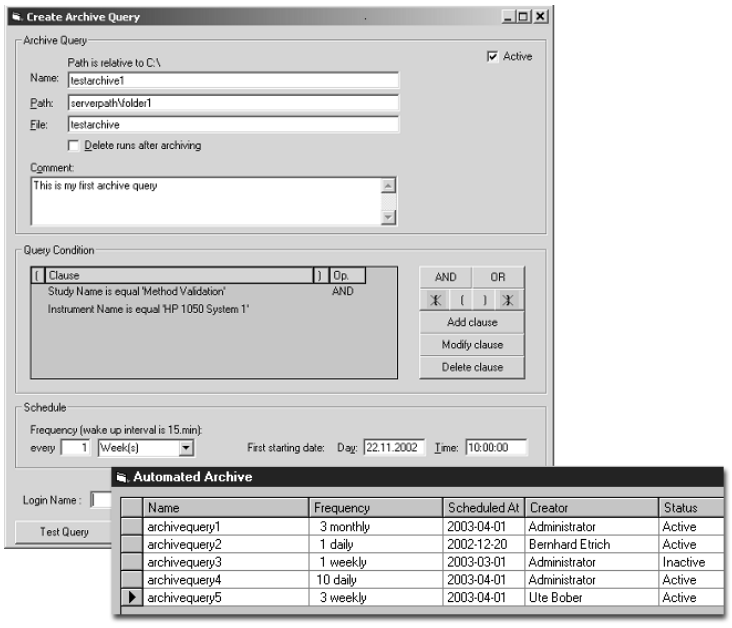

Figure 13
Setup of automatic archive queries

Each archive query is stored under a unique user-defined name and can be executed based on a configurable time interval (per query), for example, daily, weekly, monthly or in conjunction with a counter such as every x days. A test functions allows the user to obtain information on the number of runs that the query returns at the moment with the given query condition. For each archive query the name and path for the archive unit have to be specified. The filename for the automatic archive file is appended with the archival date, resulting in a file name format "<filename>-yyyy-mm-dd". Each archive query can be disabled when not required permanently. After successful completion of the archive the data can be automatically deleted to create free space in the database.

Both manual and automatic archival require re-identification with user-ID and password.

A checksum-protected archive catalog file in XML format is generated with each archive unit, which contains detailed information about the content of the binary archive file. A generic archive interface provides a closer linkage to other applications for enhanced archive management (for example, archive management or hierarchical storage management systems).

Agilent ChemStore C/S — LIMS Connectivity

ChemStation Plus can be easily connected to a Laboratory Information Management System (LIMS). For this purpose the Agilent ChemStation provides for a sample list import function to conveniently translate a work list from the LIMS into a ChemStation sequence. An instant, file-less result transfer back to the LIMS from the ChemStore C/S database (server only) is achieved through the integrated ChemStore C/S LIMS interface.

Sample list import from LIMS

The sample list generated by the LIMS can be imported to the Agilent ChemStation as a ChemStation sequence in XML-file format. XML is a very portable and flexible protocol for interconnectivity between systems.

The sample list must contain a LIMS ID for each sample. This LIMS ID is mandatory for sample tracking from and result transfer to the LIMS. Optionally additional two fields can be populated with LIMS-specific data.

Result update to LIMS

ChemStore C/S provides for file-less access to all result data stored in the database as LIMS data (identified by the LIMS ID). This is achieved through a combination of read-access to all result data in the database as well as a controlled write-access for the LIMS. Prerequisite for results to be accessible by LIMS is the existence of a LIMS ID which is assigned per sequence line. In addition a LIMS notification may be used, which is tied to the approval of data as shown in figure 14. The administrator may decide which approval level is appropriate to initiate the LIMS transfer. In addition the LIMS can acknowledge data that was successfully transferred to LIMS to exclude it from future updates.

Workflow

The workflow can be divided into five sequential activities shown below:

1 The sample list is generated by the LIMS system in an XML format
2 It is imported by the Agilent ChemStation and translated into a ChemStation sequence
3 Samples are analyzed, results are calculated and stored in the ChemStore C/S relational Oracle database

4 Information typically required by LIMS systems are instantly made accessible in the ChemStore C/S database (tied to the existence of the LIMS ID)
5 If enabled on the system or for a specific study, a LIMS notification is triggered upon the approval of data (as configured in the approval configuration console)
6 A program from the LIMS systems can scan a table in the database for a specific update flag to see if any new records are available for processing, and can amend the flag so that it is not scanned during subsequent scans.

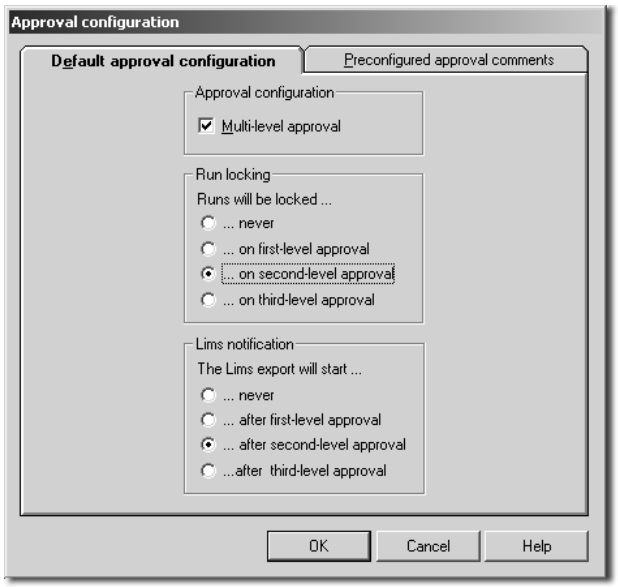

Figure 14
Configuration of approval levels and LIMS transfer

Agilent ChemStore C/S — Installation and Upgrading

The standalone version of Agilent ChemStore C/S is user-installable from the ChemStore C/S CD-ROM and can be added to an existing ChemStation installation (Agilent ChemStation software family CD-ROM version B.04.01 or higher).

The Agilent ChemStore C/S Oracle client/server version includes :

- ChemStore C/S server software (included on the ChemStation Plus CD-ROM),
- Oracle 10g standard edition version 10.2.0.4.0 (included in ChemStore C/S server software on a separate DVD),
- ChemStore C/S client software (on ChemStation Plus CD-ROM).

Agilent ChemStore C/S database migration

The Agilent ChemStore C/S system includes a migration utility which enables you to migrate your Agilent ChemStore C/S data in the following ways:

- Migrate Agilent ChemStore B.0x.0x data (standalone) to Agilent ChemStore C/S B.04.02 (standalone).
- Migrate Agilent ChemStore B.0x.0x data (stand-alone) to Agilent ChemStore B.04.02 (standalone).
- Migrate Agilent ChemStore C/S B.04.02 data to Agilent ChemStore C/S server data.

If you are currently running Agilent ChemStore B.01.0x, B.02.0x, or B.03.0x on your system, and you wish to migrate your data to the Agilent ChemStore C/S server Oracle database, you will need to migrate in two steps. First migrate to the B.04.02 Agilent ChemStore C/S standalone database, then migrate from there to the Oracle database.

Standalone version

The complete Agilent ChemStore C/S standalone software is provided on the Agilent ChemStation Plus CD-ROM as described in table 6a.

Agilent ChemStore C/S server

The Agilent ChemStore C/S server product includes the ChemStation Plus CD-ROM and Oracle10g revision 10.2.0.4.0 software on a separate DVD offering one Oracle standard edition license. In addition an application-specific full user license is required and sold from Agilent for each additional user running a ChemStore review client. Five application-specific named user licenses are already included with the Agilent ChemStore C/S server software. Refer to table 6b for details.

Description	Product No.
Software module to add Agilent ChemStore C/S to an existing ChemStation for GC, LC, LC/MSD, CE, CE/MSD or A/D.	G2181BA
License to use the ChemStore C/S database module on another computer. Must either be on the same order as G2181BA or the customer must supply the license number for the original software. Does not require ChemStation.	G2186BA
ChemStation Plus client upgrade software, upgrades a single ChemStation Plus client to the latest software revision. Requires valid software licenses and ChemStation upgrade software G1656A.	G1657A

Table 6a
Agilent ChemStore C/S standalone version

Description	Product No.
ChemStore C/S client/server version. Includes ChemStore C/S server software Oracle standard editions, 5 Oracle application-specific named user licenses.	G1410A Qty: 1 per server
Oracle named user license for Agilent NDS Required for each additional named user of the ChemStore C/S server database.	G1411A Qty: (number of named users) –5
Software module to add Agilent ChemStore C/S to an existing ChemStation for GC, LC, LC/MSD, CE, CE/MSD or A/D.	G2181BA Qty: 1 per server
Licence to use the ChemStore C/S review client on another computer. Includes one online ChemStore license for use with an online data acquisition ChemStation plus an additional offline ChemStore license for offline data review	G2186BA Qty: (number of clients connected to the server) –1
ChemStation Plus client upgrade software, upgrades a single ChemStation Plus client to the latest software revision. Requires valid software licenses and ChemStation upgrade software G1656A.	G1657A
ChemStation Plus server upgrade software Upgrades ChemStation Plus server software to the latest revision. Includes G1656A ChemStation software upgrade. Requires valid software license and can only be ordered along with a Software Maintenance Agreement.	G1655BA

Table 6b
Agilent ChemStore C/S client/server version

2. Agilent ChemStation Plus Security Pack

Product Description

The ChemStation Plus Security Pack is a module of the Agilent ChemStation Plus Series designed to support the requirements of 21 CFR Part 11. In the Agilent ChemStation the ChemStation Plus Security Pack modifies data analysis and provides advanced data management with regard to supporting the requirements for electronic records. It also offers a procedure to sign off runs with an electronic signature. To support the typical approval workflow in a regulated laboratory the Security Pack optionally provides for three levels of approval which can be combined with run locking. It offers an easy upgrade for an existing ChemStation installation.

The Agilent ChemStation Plus Security Pack is compatible with the following ChemStation modules:

- Agilent ChemStation for GC, LC, A/D, CE, CE/MS and LC/MS for instrument control and data analysis
- Agilent ChemStore C/S data organization and data storage module

The UV-Vis as well as GC/MS ChemStation offer separate solutions for 21 CFR Part 11. Please refer to the specifications of the UV ChemStation Security Pack and the MSD Security ChemStation included in publication number 5989-9914EN and 5989-3015EN, respectively.
The ChemStation Plus Security Pack is available as a standalone solution or in a fully integrated client server network connected to the ChemStore C/S server Oracle database. It provides full support of 21 CFR Part 11 by offering advanced data security, data integrity and full change documentation in audit-trails. Specifications of the ChemStore C/S database module are available in the ChemStore C/S section of this document.

To achieve data security, the ChemStation Security Pack utilizes a combination of Windows user accounts and file permissions and auditing. In addition, it utilizes an application-related second layer of data security based on standard database security features. The application-related security requires a valid ChemStation Plus user account allowing the log-on to the application. A user with administrative priviledges can assign appropriate user permissions to other users within the ChemStation Plus software.

The ChemStation Plus Security Pack software allows to match user tasks in the laboratory with user roles in the software. It modifies the ChemStation operator rights, allowing to routinely operate the ChemStation application in the operator mode. For proper use and to achieve the best data security capabilities all users except those with administrative functions should utilize the ChemStation operator mode.

To achieve data integrity, all users are required to log on to a single database. This database (determination of the database connection requires the log-on to the Windows operating system with a Windows administrator account) will store all raw, meta and result data. In addition, any recalculation of results in the ChemStation will automatically be recognized as a new result version and will be transferred to the database as a new version. This versioning assures that no data is ever lost or overwritten and that a complete chain of events is documented. If a new result version is generated interactively, the user is forced to enter a mandatory comment, which is written to the audit trail.

To achieve data traceability, the ChemStation Plus Security Pack utilizes logbooks and audit trails that document who did what, when and why. These logbooks and audit trails are user-independent and cannot be modified or deleted.

All data is in electronic format and capable of long-term storage through archive/restore as well as viewing and printing in human readable format.

Key product features of the ChemStation Plus Security Pack include storage of all chromatographic data in a relational database, secured through

- password protection to access the data,
- full data protection using Windows security and database security features,
- application protection with a mandatory log-in, consisting of both identification components - user-id and password,
- user management with individual user profiles and privileges for the application – independent of the user privileges assigned for the operating system,

- an application-specific session lock allowing to explicity lock one ChemStation session while leaving a second instance running on the same PC, and
- a configurable time-based application lock to lock the current ChemStation or ChemStore session after a specified time of inactivity and thus avoids any unauthorized access to the application.
- A completely revised ChemStation operator access level which allows operating the entire application as ChemStation operator.
- A configurable access to the ChemStation commandline independent of the ChemStation user level, thus also preventing access for ChemStation managers.
- A modified batch review interface providing an automated user-independent data versioning with detailed audit-trails for all modifications.
- Complete change control documentation for methods and manual integration changes.
- Four levels of audit-trails for data acquisition, data analysis application tasks and security violations.
- Electronic signatures for each result version following the guidelines of 21 CFR Part 11.
- Three configurable levels of approval.
- Optionally locking of runs upon the approval to prevent them from further modification.

ChemStation Plus Security Pack — System Requirements

Client hardware requirements

The following list shows the minimum hardware requirements for this application:

- 1.5 GHz Pentium IV processor
- 4 GByte of free hard disk space
- 512 MB RAM for single ChemStation instrument.
- 1 GB RAM for two ChemStation instruments
- Display: 1280 x 1024, small fonts, true colors
- For Windows Vista operating systems the minimum requirements in respect to processor speed and memory are:
  3.4 GHz Pentium IV
  1 GB RAM

Client software requirements

The following list shows the minimum software requirements for this application:

- Windows Vista Business Ed. with Service Pack 1 or Windows XP Professional Service Pack 2
- Agilent ChemStation revision B.04.01 or later
- Microsoft Internet Explorer 7.0 or later
- A local or network printer must be installed and configured.
- The hard disk partition that is used for installation of Security Pack must be formatted with NTFS.

The standalone database size is limited to 800 MB due to some strict size limitations in the underlying file format. To ensure optimum performance for later data review Agilent strongly recommends not to exceed this database size limit. A configurable size-checking tool automatically launches a warning message when the specified size limit is reached.

If a larger single database is required, Agilent recommends that the client/server version of the product be purchased. The client/server database uses Oracle, which allows for a much larger database. Table 9 gives some data on the time required for downloading data from the standalone database into the active memory of the client. The time mainly depends on the size of the standalone database, the number of runs marked for download and

the performance charactistics of the computer. All runs were stored with raw data, methods, sequences, and all result versions. Tests were performed on a PC with an Intel Pentium IV Dual Core processor, 2 GHz, 2 GB RAM, and no data acquisition running in the background).

Database Size	No. of peaks	No. of runs	No. of runs loaded from database	Time [s]
670 MB	71,000	5,200	100	4
			1900	16
350 MB	26,000	1,300	100	3
			500	6
120 GB	2,000,000	500,000	100	13
			1700	36

Table 9
Run download time depending on the number of runs selected for download and the database size.

Working with ChemStation Plus Security Pack

Result management

The ChemStation Plus Security Pack is designed to store ChemStation data in a relational database by transferring it as a post-data analysis spooling job to the database. Depending on the laboratory workflow the data analysis can also be separated from the acquisition. In this case only raw and meta data are automatically spooled to the database, without a first set of data analysis results (data is acquired in acquisition-only mode). The ChemStore C/S ODBC spooler is a proprietary tool managing the transfer and protecting data against loss, modification or damage in case of transfer problems or network errors.

Data protection

Using the Security Pack in the standalone version, all data is stored in a single database file. The subdirectory storing the database files is protected with Windows file security permissions and only allows write access for members of the Windows user group.

The application denies access to data without a valid ChemStation Plus user-id and password. Any attempt to access the data in the standalone database directly with another application such as MicrosoftAccess fails as it requires a password/user-id combination that is strictly confidential and only known by Agilent. It is not known by or given to any Agilent customer or user of this product.

In client-server installations of ChemStation Plus Security Pack direct, uncontrolled access to data in the Oracle database without using the ChemStore user interface is virtually impossible. This is because users must have a valid Oracle user account and they must have access to the data dictionary describing the meaning and contents of the Oracle tables and table columns. The dictionary is only available from Agilent Technologies against a written Confidentiality Agreement and should not be available for application users. Overall the attempt to falsify or delete data requires the collaboration of the user and the database administrator that provides the direct database access. Sufficient security constraints need to be imposed within the organisation to prevent any uncontrolled modifications.

Data storage

By default the the database stores the following data:

- calculation results of the ChemStation,
- contents of the ChemStation data directories; the *.d directories including the chromatographic raw data files,
- current method used for data acquisition and data analysis,
- current sequence, if a sequence was run to acquire or reprocess data,
- sequence, run and method logbooks,
- detector channel chromatograms as images according to the report configuration of the method, and
- apex spectra of all identified peaks in a chromatogram, when using a 3D detector.
- Optionally all peak performance parameters independent of the ChemStation method.

Protection of temporary data files

The ChemStation uses a given data directory structure to store acquisition and result data. The ChemStation Plus Security Pack also protects this data. After completion of data acquisition and a first result calculation, by default the data transfer is immediately initialized through the ChemStore spooler and the *.d directory with all its contents is deleted from the local hard disk (these default settings can only be modified by a user with administrative rights in the database). From then on, the data security mechanisms of the database itself secure the data. The temporary directory where the database spooler stores intermediate data is protected using Windows NTFS file and folder security.

If a first pass review in the ChemStore review client results in the need for some reanalysis work, for example reintegration, the data is submitted as a batch to ChemStation. This requires restoring data files to a temporary subdirectory. The Security Pack protects this subdirectory chem32/x/data/chemstor where x is the instrument session number with read-only access for members of the Windows users group thus denying unauthorized access for operators.

Configuration and data protection using Windows security features

For security reasons, a user must be a member of the Windows user group *Administrators* or *Power Users* to access the configuration of the ChemStation Plus Security Pack. It restricts access to all data directories on the local PC with important information using the Windows users group privileges. The default configuration automatically sets all directory permissions and access limitations as part of the installation using the Windows groups “Users”, “Power Users” (on Windows XP only) or “Administrators”. Each ChemStation user has to be member of either one of the groups.

Note:
Normal users must not be members of the Windows Administrators nor Power Users groups. The membership to these groups should be dedicated for system administrators.

Table 10 gives an overview of the permission rights that are limited to members of the Windows Adminstrators and Power Users (XP only) groups.

User task	Granted to members of Windows User group	Granted to member of Power Users or Administrators group
Create a new MS Access database	no	yes
Configure database Alias	no	yes
Access the ChemStore ODBC spooler to resume interrupted data transfer	yes	yes
Access to the selection list of available databases	no	yes

Table 10
Tasks requiring membership in the Windows Administrators or Power Users group

Local directories storing relevant chromatographic data are also protected with Windows file and directory permissions. Table 11 gives an overview of the Windows permission rights on the data directories and files on the local hard disk. The first item in brackets displays the permission rights on the folder; the second item displays the individual file permission rights.

Note:
Windows file security does not give any access to a folder or directory for users that do not have access rights to the folder, even if the user has control over the files in the folder.

File path	Permission Windows Users	Permission Windows Administrators or Power Users	Directory/file owner	Data directory contents
\chem32\chemstor \database	(W)(full)	(full)(RWXD),	All members of local Administrators or Power Users group	Contains database *.mdb file storing all raw and meta data
\chem32\chemstor \spool	(WX)(full)	(full)(RWXD)	All members of local Administrators or Power Users group	Spooler jobs and data files
\chem32\chemstor \hputil00.exe	none	(full)	All members of local Administrators or Power Users group	Access to ChemStore utility tool to create/ copy and manage local database files
\chem32\X (instrument session number)\data\chemstor	(WX)(Full)	(full)(RWXD)	All members of local Administrators or Power Users group	Stores data files reloaded from ChemStore database to ChemStation batch review

Table 11
Directory and file permissions [(directory)(file)] set by the ChemStation Plus Security Pack [W=write, R=read, X=execute, D=delete, full=all permissions]

ChemStation Plus Security Pack — User Management and Application Security

User management and ChemStation Plus Security Pack user access rights

Security Pack provides a fully integrated user management that is independent of the Windows operating system. The user management covers both the ChemStation Plus data acquisition and data analysis tasks and the ChemStore C/S database data review privileges. The entire user administration itself is a user-privilege granted to administrators in the ChemStore C/S database. The ChemStation Plus Security Pack includes a modified ChemStation operator level allowing operators to perform all important acquisition and data analysis tasks for daily operations. Table 12 shows the most important changes in user privileges compared to the standard ChemStation for data acquisition. The ChemStation Manager always has access to all tasks within the ChemStation with the exception of access to the ChemStation command line. Unlike the standard ChemStation this privilege can be assigned individually and is not tied to any ChemStation user level (see figure 15). A detailed documentation of the data review user privileges in the ChemStore C/S database is in the ChemStore C/S concept guide.

User privilege	Security pack operator	ChemStation operator
Save acquisition method	no	no
Save data analysis method	yes	no
Load/run/save sequence	yes	yes
Modify acquisition parameter	yes	yes
Re-Integrate chromatograms manually	only in batch review	no
Change integration events	only in batch review	no
Recalibrate overview and peak summing	only in batch review	no
Recalibrate other	no	no
Apply method to data and print report	yes	yes
User-independent automated result versioning	yes	no
Access to tasks with manual result versioning	no	no

Table 12
Comparison of user privileges in the ChemStation Plus Security Pack and the standalone ChemStation

Application security

The Security Pack only allows users with a given user-ID to log on to the ChemStation Plus application, as shown in figure 12. Users need to be set up by the administrator to gain access. At initial login, users must specify their initial password in order to keep it unique to each user. Protecting the application software from unauthorized access during operation is possible with a separate session lock (figure 16). This lock function offers

- an interactive session lock which should be enabled manually before leaving the computer unattended, e.g. during a break or shift change, and
- for enhanced security a time-based automated lock of the session for other periods of short-term absence from the computer.

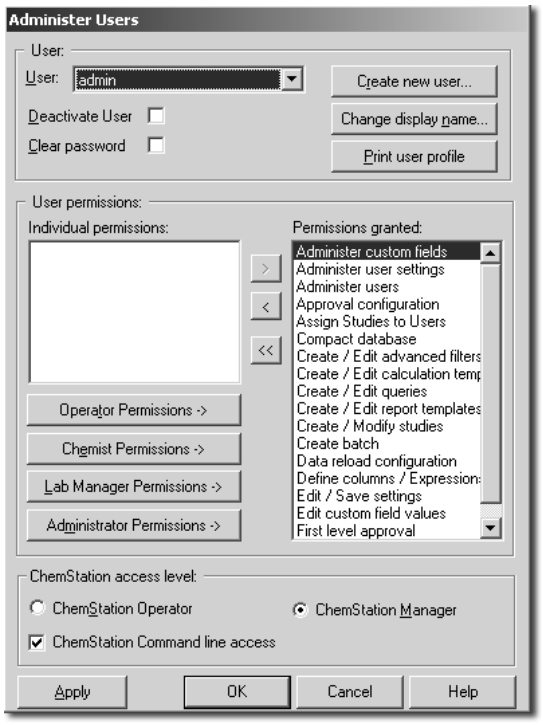

Figure 15
User Management in ChemStation Plus Security Pack

The time-based session lock is configured centrally through users with administrative rights in the ChemStore C/S database, and is automatically applied on all connected ChemStation Plus clients. The session lock allows to lock each instrument session individually and independently, so users sharing computers with two or more instruments connected to one computer can operate with a clear user distinction and unique user identification. The name of the current user and the instrument session are always shown in the title bar. The instrument sessions can be locked either

- privately, allowing only the user who locked the session or an administrator to unlock it, or
- non-privately allowing all users with a valid user-ID in the database to unlock the session, for example during shift changes (figure 16). If a dialog is still open the application will automatically lock privately.

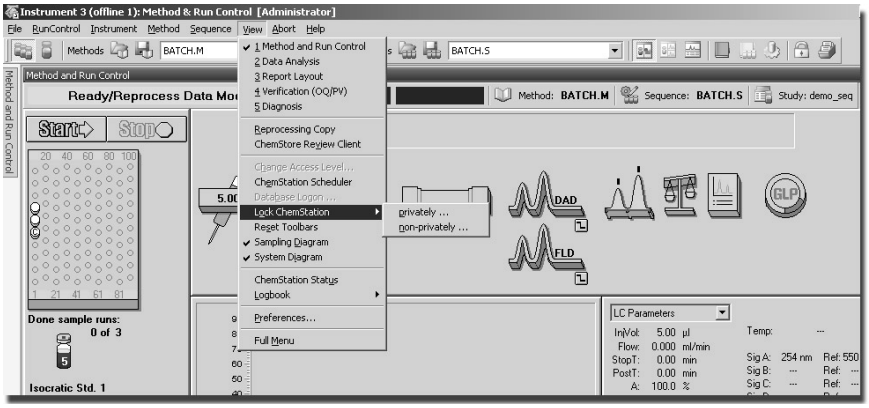

Figure 16
Instrument session lock

Data integrity

The Security Pack maintains full data integrity by storing all results along with the raw and meta data in a relational database as shown in figure 17.

Result revision management

Daily work in the analytical laboratory often requires sample reanalysis. The ChemStation Plus Security Pack includes a result versioning that stores all recalculation results from one original injection as result versions. In addition, the application software includes a tool that automatically detects new results during the reanalysis process. This application-controlled automated process does not require any user interaction such as *Save Results* or a similar action. It is completely user-independent and covers the following reanalysis steps:

- All functions in the batch review that calculate or change results such as reintegration, recalibration, method modifications (for example changing compound names) execution of predefined methods including manual reintegration
- In the data analysis view: Integrating, printing reports and recalibration excluding manual reintegration

Sequence reprocessing as well as all initial review tasks (loading a batch from disk, initial loading of a run into the interactive data analysis view) always create new result versions. These reanalysis tasks cover all activities of the ChemStation operator thus ensuring that all reanalysis steps at the ChemStation operator level include a user-independent versioning.

In addition, ChemStation Plus managers can perform manual result manipulation interactively in the Data Analysis view withoutusing the batch review user interface. The user-independent revision management does not cover the manual reanalysis of results in the standard ChemStation data analysis view. The user creates new result versions in this review function by generating a report preview(figure 18).

The following manual tasks in the Data Analysis view, outside of batch review, require a user selected *Transfer Data to Database* command to create a new result version:

- drawing a manual baseline,
- deleting a peak,
- tangent skimming of one peak,
- splitting a peak, and
- integrating manually with a negative baseline.

Access to tasks with a user-dependent creation of new results is the only difference in the result management between the ChemStation Security Pack manager level and the ChemStation Security Pack operator level. The new result version in the database is the same for both automated and user-dependent data transfer.

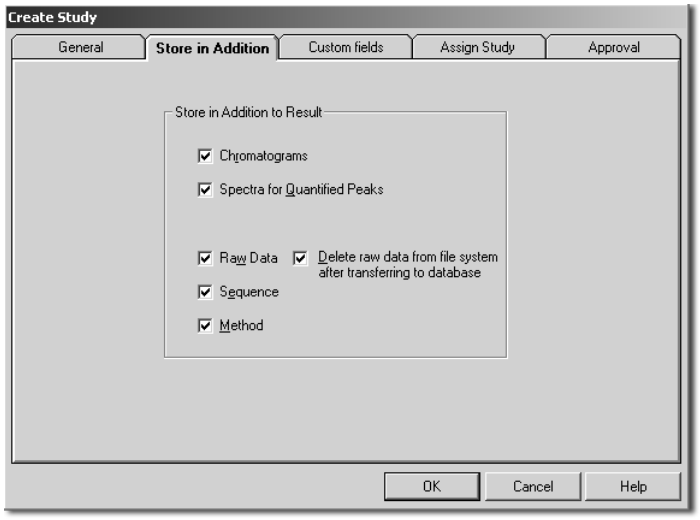

Figure 17
Default configuration of data storage in database

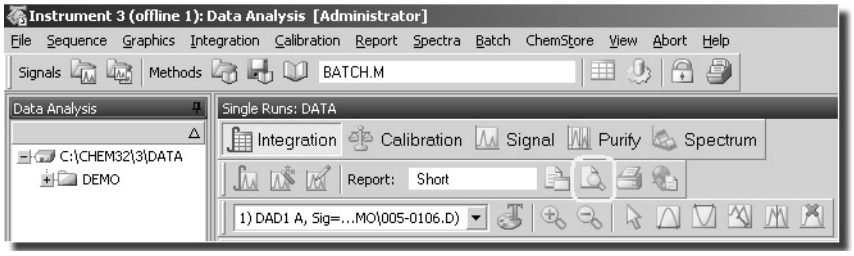

Figure 18
Manual revision management

User-independent, automated result version management

The data storage includes an application controlled version management that is based on the creation of a result reference file. Prior to reprocessing, the application software creates a binary result registry file called *save_sec.reg* for each file. This *save_sec* register is stored along with the raw data. It includes all numeric results of the current result revision in a binary format, such as amount, compound retention time and so on. Whenever a new result is calculated, the software automatically compares the new run result with the original result in the register file. If the results changed, the software detects the difference between the most recent and the current result and creates a new result version.

For proper documentation of the changes, the application software creates a second file in a human readable format that stores the results of the comparison and documents the changes. The file is named *sec_trac.txt* and is stored along with the raw data in the *.d subdirectory, as shown in figure 19). Both the registry and the text file are also stored in the database along with the raw data and they can be restored to disk with the data file, if necessary. These changes including manual integration events are also documented in the Manual Integration Events section of the ChemStore audit-trail as shown in figure 20. The audit trail as well as the sec_trac.txt can be used in order to regenerate the result from raw and meta data at any time, for example in an audit situation (see also

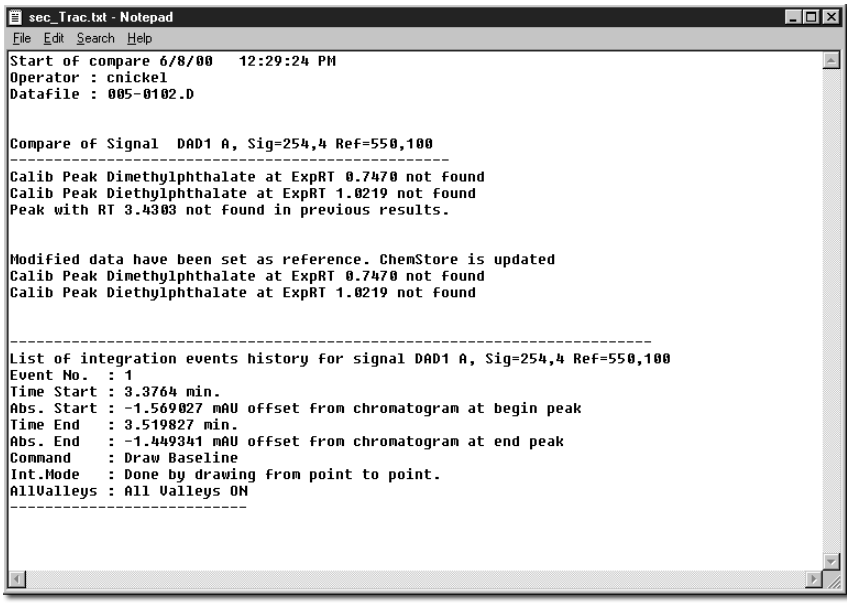

Figure 19
Text file documenting result changes for the actual run revision

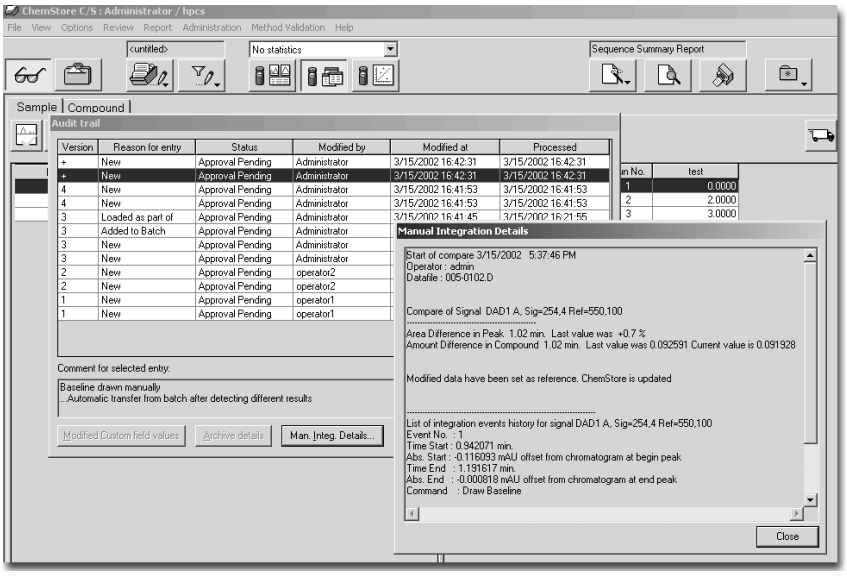

Figure 20
Manual integration events documented in ChemStore run audit-trail

Application Note "Handling of Electronic records with ChemStation Plus" publication number 5988-9643EN.

Summary of version management in the ChemStation Plus Security Pack

Each time a new result is calculated in the ChemStation, the application compares the values with the result values of the last reprocessed result copy. If it detects a difference, it automatically initializes the data storage in the database. Each data transfer of new results creates a new version entry in the database so that no data is ever overwritten. The versioning also assures that no "data" is lost and that a complete "chain of events" is documented. This ensures full data integrity and traceability.

Agilent ChemStation Plus Security Pack—Graphical Result Review and Calculation

The graphical result review for example inspecting the baseline of the chromatogram or zooming in to check the integration, is done in the ChemStore review client. If any further rework is required the data is submitted to the ChemStation batch review user interface for data reanalysis. In batch review the ChemStation Plus Security Pack allows splitting the review into a working and a calculation section. The application allows a graphical rework of the chromatogram for each run that was included in the batch. This is done by setting new integration events and applying manual events such as baseline drawings and others without an immediate transfer to the database. The transfer is initiated automatically as soon as the user has finished his work and decides to calculate the results with the new settings by moving to the next run or starting an automated result recalculation (figure 21). As soon as new results are created, the result transfer to the database is performed either for the single run, or if starting an automated result recalculation, for all reprocessed runs. During the transfer of manually integrated data the user is prompted for a mandatory comment that is written to the results audit trail. The comment can be either a selection from a set of predefined comments or a free text or a combination of both. After finishing the data reanalysis and closing the batch review interface, the temporary files will be deleted from the local hard disk.

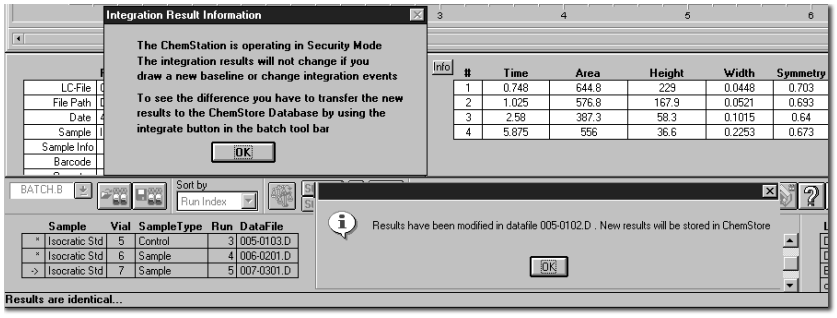

Figure 22
Result calculation and automated versioning

21 CFR Part 11 permits the use of electronic signatures if the application ensures data integrity, data security and full audit-trail documentation. If an electronic signature is supposed to be equivalent to a handwritten signature it must contain at least two distinct identification components such as an identification code and a password.

Approval of results

The ChemStation Plus Security Pack protects all activities that create, modify or delete electronic records with user privileges and electronic signatures. Signing for approval is a privilege that must be configured and granted by the system administrator and is therefore limited to certain users. Signing runs for approval or rejection always prompts for a re-identification and password confirmation of the signer for each run, plus a mandatory comment for the sign off, as shown in figure 22. The signer has to be the currently logged-on user.

ChemStation Plus provides three levels of approval tied to two separate user permissions to support the typical approval workflow in an analytical laboratory. It can be configured on a study level whether multiple approval levels should be applied or not. The approval configuration is part of the study settings. For new studies the settings from the global approval configuration template are copied to the study. The approval configuration is shown in figure 23.

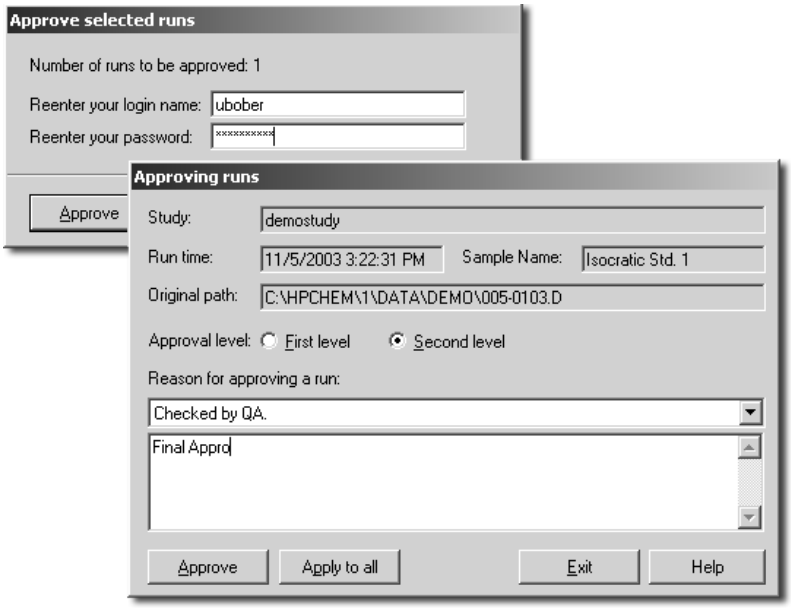

Figure 22
Signing off results requires reentry of user-ID with password confirmation and a mandatory comment

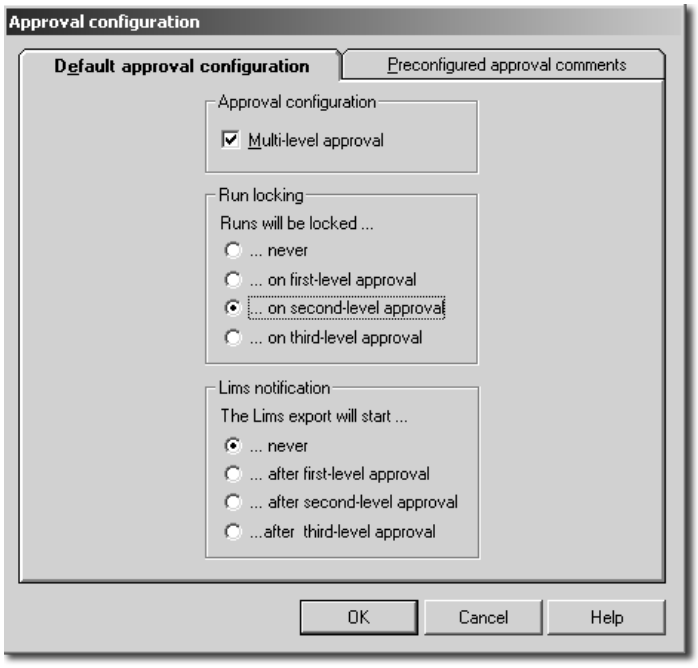

Figure 23
Global approval configuration template

The operator will typically give the first level approval when reviewing his results. To allow for peer reviews the application supports multiple first level approvals. The second level approval lies in the responsibility of the laboratory manager when signing off the results and prevents a signed run from further first level approvals, unless the run is rejected. The third level approval (equals a 2nd second level approval) can serve as the final sign-off by the quality control department. It requires the signing user to have the second level approval permission. After the third level approval no more signatures can be applied unless the run is rejected. Optionally runs can be locked from reanalysis after the approval (see figure 23). Which level finally locks the run is configurable. The administrator assigns the permissions for the different approval levels to the users.

Preconfigured approval comments

The ChemStation Plus Security Pack provides the ability to globally define approval comments. These comments consist of two components - a short fixed text that cannot be modified nor deleted by the signer and a pre-defined default text that can be changed during the signing. These two components appear during the approval. The signer has to choose a fixed comment from the dropdown list box containing the pre-configured comments as shown in figure 22 and can optionally enter or change the free-text comment. The approval comments are defined by the administrator in the global approval configuration template.

All other sensitive actions (for example, changing run-related custom field values such as the batch ID) and the archival or deletion of runs follow the same process as described above and are tied to distinct user permissions. All electronic signatures are noted in the individual sample audit-trail and in the database logbook.

The ChemStation Security Pack uses electronic signatures based on the application User-ID/password combination to uniquely identify the user and his or her signature. In order to keep the password unique to the individual user an additional security function is implemented to periodically check and revise passwords, and apply the company's password policy (figure 24). The administrator can specify the values for these conditions.

- Minimum length is the minimum acceptable length (in characters) of a password. Passwords shorter than the minimum length are invalid and rejected by ChemStore C/S. The default is eight characters with a valid range between 0 and 30.
- Password expiry date is the number of days over which the password remains valid. The password expires after the specified validity, and a new password must be provided. The default is 90 days with a valid range between 1 and 32000.
- Password uniqueness is the minimum number of new, unique passwords that a user must use before a password can be re-used. The default is 12, which means that a user must change the password at least 12 times before re-using the original password. The range is between 0 and 32000.
- Account lockout after 'x' attempts (where 'x' is the number of failed log-on attempts) is the maximum number of consecutive unsuccessful attempts that a user can enter before ChemStore rejects the user. The default is three with a valid range between 0 and 32000. If the maximum number of re-entries is reached, the current user is invalidated and must be reactivated by a user with the required permission.

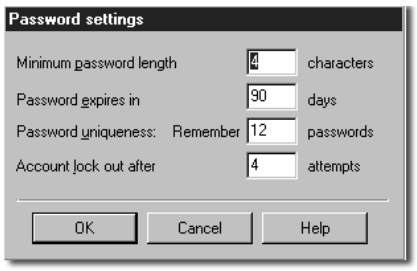

Figure 24
Password policy

The Agilent ChemStation Plus Security Pack includes four audit-trails:

- run logbooks,
- method revision history data,
- sample audit-trail, and
- database logbook.

Run and sequence logbook

During data acquisition, all events are documented in the sequence and run logbooks with date and time stamp (figure 25). The sequence and run logbook documents all data acquisition events such as

- start and execution of methods
- the actual sequence line in the sequence table,
- any failure during method execution, and
- any modification of method parameters during the analysis, such as manually extending the run time
- initialization of data spooling to the ChemStore C/S database.

Method changes

The method changes are stored with each current method version including a mandatory user comment for the change (figure 26). The method audit-trail stores

- the time of change and the operator who performed the change
- the current method revision in the database, and
- a mandatory comment of at least five characters each time the method was saved to disk.

Sample audit trail

The sample-related audit-trail, shown in figure 27 documents

- all changes and modifications, on one sample,
- all run versions,
- all user comments during reanalysis cycles, and
- a detailed change documentation of manual integration events.
- all approval events including the name of the approver, date & timestamp, approval comment and the level of approval.

All reanalysis events and result versions are documented in the sample audit-trail. The sample audit-trail creates for each result change one new line in the audit-trail table. It displays both the interactive manual changes and the system generated entries each

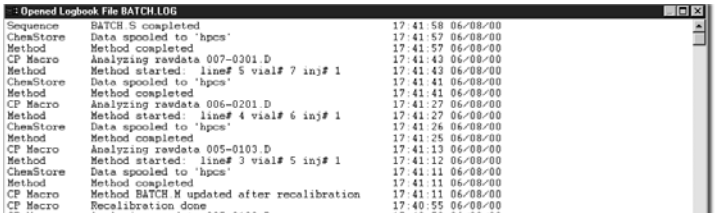

Figure 25
Run and sequence logbook

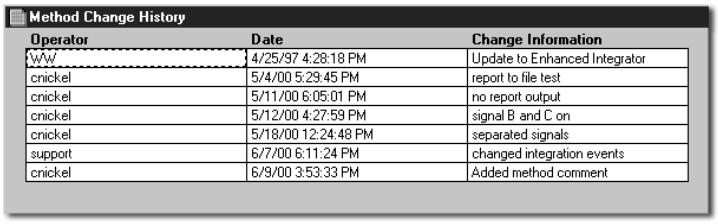

Figure 26
Method change audit-trail

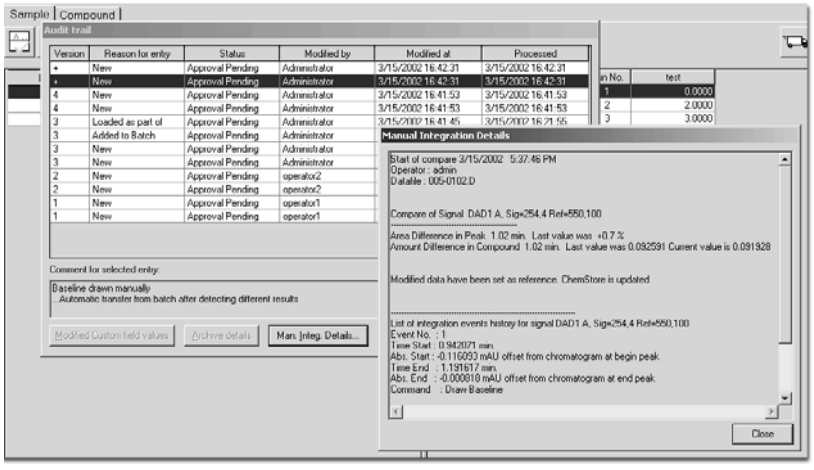

Figure 27
Audit-trail table with manual change documentation in the comment field

in a separate line. Examples for manual interactive changes are:

- change of custom field values
- manual reintegration during reanalysis,
- approval, rejection and retransfer to batch,
- reloading data to disk,
- archiving and dearchiving, and
- re-opening of read-only runs.

The automated entries in the sample audit-trail are created when

- a run is transferred to the database
- a new result version is created
- a run is reloaded in the ChemStation batch review interface for reanalysis.

Database logbook

The database logbook (figure 28) stores all application related activities such as:

- log-on/log-off events and failed logon attempts,
- archive/delete/reopen activities,
- session locks and unlocks,
- approval and rejection of runs,
- modification of custom fields and custom field values,
- changes in user administration,
- modification of user permissions,
- password resets and password clearance, and
- database migration from Access to Oracle.
- Account lockout events.

Review of method parameters

Each result version is associated with its ChemStation method that is stored in the relational ChemStore database. To inspect the differences in method parameters between result revisions or to review a method that was used to generate a specific result the application provides direct access to the method information from the ChemStore user interface. All method parameters, including acquisition parameters, data analysis parameters and calibration information can be reviewed in read-only mode as well as printed. The method report header contains information on

- the associated result version,
- method name,
- method modification date,
- study name,
- database name,
- sample name,
- injection date and
- acquisition instrument.

Changes to method parameters can only be applied in the ChemStation. For this purpose the method has to be restored from the database. New result versions generated with the modified method are spooled to the database along with the method.

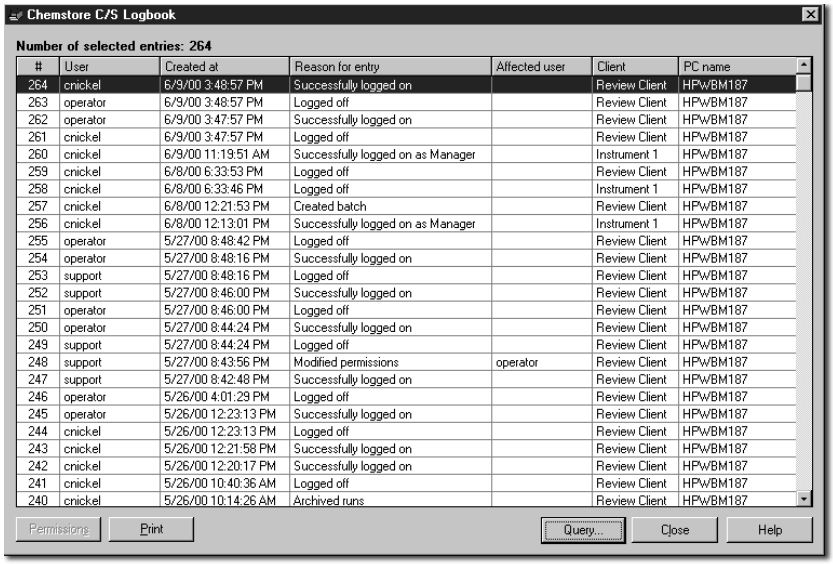

Figure 28
Database logbook

The email notification feature (client-server only) allows to send an email to a configurable list of recipients on the event of

- account lockout
- batch submission
- user permission change
- user creation

For each event the recipients can be defined separately as well as a user-defined message text and subject.

This function requires an e-Mail server to be running in the network. The e-mail message can be transferred to the e-mail server through Simple Mail Transfer Protocol (SMTP). For example this can serve for the purpose of instant notification on unauthorized attempts to access the database. An e-mail message can be triggered by account lockout events in the ChemStore C/S database logbook. (figure 29).

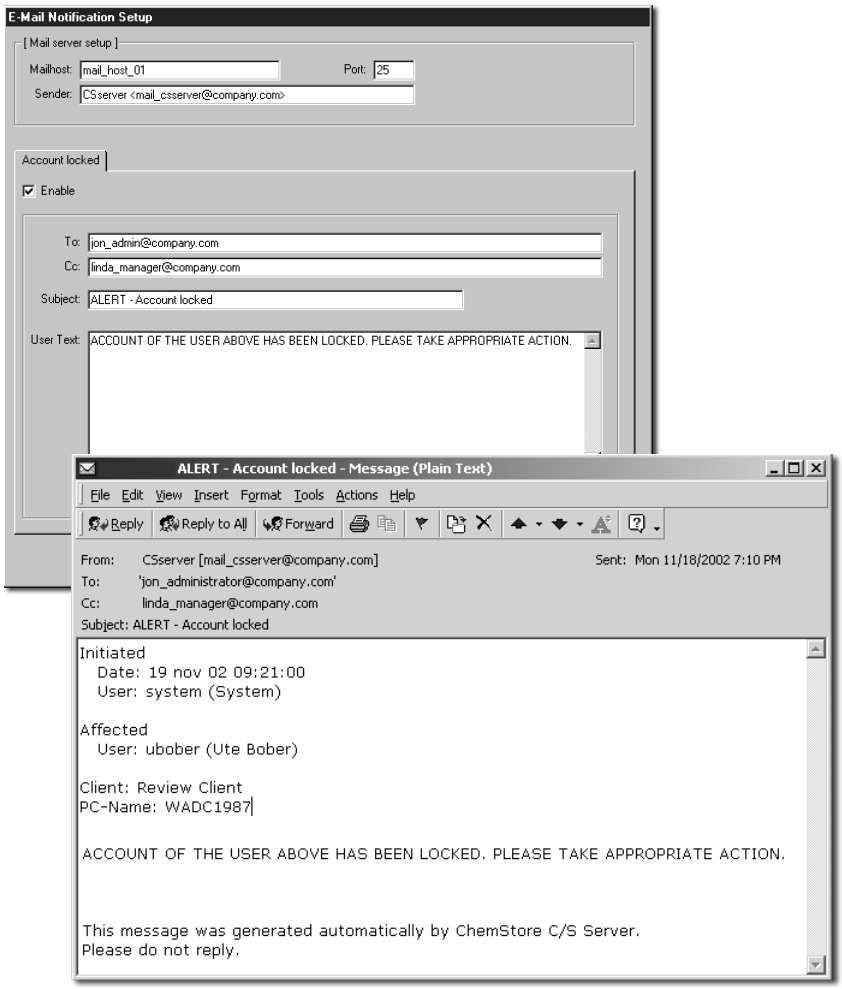

Figure 29
Setup of e-mail notification

ChemStation Plus Security Pack—Product Options and Configuration

Standalone version

The standalone version provides the ChemStation CD-ROM revision B.04.01 or higher and the ChemStation Plus CD-ROM revision B.04.02 or higher as described in the table next to this text.

Description	Product No.
ChemStation Plus Security Pack. Adds the secure ChemStore C/S relational database add-on software module to the ChemStation Plus SW for A/D, GC, CE, LC and CE/LC-MSD. Supports 21 CFR Part 11. Includes user documentation, licenses and media.	**G2183AA** 1 per PC 1 per laboratory
License to use G2183AA on another PC. Includes license and user information only. Supports 21 CFR Part 11. Must be on same order as G2183AA or requires a valid license for G2183AA.	**G2187AA** 1 per PC be in the same laboratory
ChemStation Plus client upgrade software. Upgrades a single ChemStation Plus client to the latest software revision. Requires valid software licenses and ChemStation upgrade software G1656A.	**G1657A**

Client/server version

The client server/version of the product consists of a set of components that are required to implement ChemStation Plus Security Pack in a client/server version. The product number are listed in the table next to this text along with the required quantities.

Description	Product No.
ChemStore C/S server application software. Includes:1 x ChemStore C/S and Oracle 9i standard edition software, 5 Oracle application-specific named user licenses are included.	**G1410A** Qty: 1 per server
Oracle named user license for Agilent NDS Required for each named user of the ChemStore C/S server database.	**G1411A** Qty: (number of clients connected to server) – 5
ChemStation Plus Security Pack. Adds the secure ChemStore relational database add-on software module to the ChemStation Plus client server SW for A/D, GC, CE, LC and CE/LC-MSD. Supports 21 CFR Part 11.	**G2183AA** Qty: 1 per server
ChemStation Plus ChemStore client license. Includes one online ChemStation Plus license for online data acquisition and one ChemStore C/S offline data review license. Includes license and user information only. Requires but does not include ChemStation Plus software media.	**G2186BA** Qty: (number of clients connected to server – 1
License to use G2183AA on another PC. Can be used as additonal copy for standalone installations or as additional Security Pack client in ChemStation Plus Security Pack C/S installations. Includes manual, 1 license for either online or offline use and media. Supports 21 CFR Part 11 Must be on the same order as G2183AA or requires a valid license for G2183AA.	**G2187AA** 1 per PC in the same laboratory.
ChemStation Plus client upgrade software. Upgrades a single ChemStation Plus client to the latest software revision. Requires valid software licenses and ChemStation upgrade software G1656A.	**G1657A**
ChemStation Plus server upgrade software. upgrades ChemStation Plus server software to the latest revision. Includes G1656A ChemStation software upgrade. Requires valid software license,and can only be ordered together with a Software Maintenance Agreement (SMA).	**G1655BA**

Installation, Qualification Services and Training

Installation and familiarization

Agilent Technologies' installation and familiarization service ensures that the Agilent ChemStation Plus is installed correctly and in the right environment.

In addition, Agilent offers a range of on-going support services to help:

- get your system up and running fast,
- resolve problems quickly,
- keep productivity high,
- extend instrument life, and
- comply with regulatory quality requirements.

Qualification services

- Agilent Technologies offers a full range of qualification services to provide the evidence you need to satisfy the requirements from agencies such as the U.S. Food and Drug Administration (FDA), the U.S Environmental Protection Agency (EPA), the International Standardization Organization (ISO), and the Organization for Economic Cooperation and Development (OECD).
- Installation qualification (IQ) service
- Operational qualification/ performance verification (OQ/PV) service

Training

Agilent's ISO-registered trainings can save you time, help keep your laboratory operating costs low, broaden your capabilities, and ensure that your laboratory complies fully with regulatory and quality requirements.
For your convenience, standardized courses are offered in selected locations worldwide. Onsite courses can be tailored to your specific needs.

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