GENERIC SPECIFICATION FOR SOFTWARE
USED TO CONTROL COMPOSITE AUTOCLAVES & OVENS

The following is a generic purchase specification that defines what ASC's customers believe to be the minimum capabilities and features that should be included in any PC-based software package designed to control composite processes in autoclaves and ovens.

This specification closely resembles those issued by major aerospace companies such as Boeing, Lockheed, GE, Hexcel, BAE, and others.

You are free to republish this specification in part or in its entirety in order to insure competitive compliance with these minimum features and capabilities.

1.0 Compliance statement

- 1.1 Vendor shall provide a statement of compliance for each paragraph below. The statement shall be either COMPLY or EXCEPTION. Vendor may include further narrative to explain the compliance statement.

2.0 Control Software Package

- 2.1 Software must be designed for and operate on Windows NT 4.0 or Windows 2000 operating system.
- 2.2 Software must be a client-server design, supporting multiple concurrent clients.
  - 2.2.1 Software must be capable of being concurrently monitored and/or controlled by multiple remote, network linked computers without the need of PC Anywhere or other remote-control software package.
  - 2.2.2 The remote client software operation should not disrupt the local client operation, allowing remote viewing from multiple PCs during normal operation.
- 2.3 Software must be field-proven in composite processing applications.
  - 2.3.1 Vendor shall provide a minimum of three (3) customer references where proposed software is controlling composite curing in an autoclave.
- 2.4 Software license shall include free updates for at least 5 years of operation.
- 2.5 Software license shall include free phone support for at least 5 years of operation.

3.0 Security

- 3.1 Software shall include a configurable security system capable of the following:
  - 3.1.1 Ability to create user accounts for each operator, supervisor, or engineer.
  - 3.1.2 Ability to assign specific and independent permissions and restrictions to each user.
  - 3.1.3 Ability to permit or restrict any software function from any specific user or group of users.
  - 3.1.4 Ability to track user login and logout operations, including time stamping.

3.1.5 Ability to program an auto-logout after a specific period of operator inactivity.

3.1.6 Ability to program an auto-logout at specific times during the day (ie. shift changes)

4.0 Screens

4.1 Customized screens shall be provided for monitoring and control of the equipment.

4.2 The following minimum screens and capabilities shall be provided:

4.2.1 Main overview screen

4.2.1.1 Run status

4.2.1.1.1 Run time

4.2.1.1.2 Segment time

4.2.1.1.3 Segment time remaining

4.2.1.1.4 Recipe being run

4.2.1.1.5 Segment comment

4.2.1.2 Process values

4.2.1.2.1 Air temperature

4.2.1.2.2 Part temperature setpoint and value

4.2.1.2.3 Pressure setpoint and value

4.2.1.2.4 Part Vacuum setpoint and value

4.2.2 Sensor viewing screen

4.2.2.1 Ability to view all thermocouple, vacuum, and pressure readings at one time.

4.2.2.2 Visual indication of sensor status (ie. enable/disable, alarmed, etc.)

4.2.2.3 Visual indication of each sensor's attachment status (ie. Part #1)

4.2.3 Trend viewing screen

4.2.3.1 Ability to view a plotted line representation of selected sensors.

4.2.3.2 Ability to select any sensor

4.2.3.2.1 Color

4.2.3.2.2 Line type

4.2.3.3 Ability to vertically zoom and/or pan the plotted display

4.2.3.4 Ability to horizontally zoom and/or pan the plotted display

4.2.3.5 Ability to change the resolution of plotting and sensor value saving

4.2.3.6 Ability to save a group of viewed sensors for quick future selection

4.2.4 Manual operations screen

4.2.4.1 Ability to take manual control of process.

4.2.4.2 Any manual changes shall be recorded as an intervention event to the alarm system.

4.2.5 Run operations screen

4.2.5.1 Enter parts

4.2.5.2 Select the recipe

4.2.5.3 Start/Stop the run

4.2.5.4 Change segments

4.2.5.5 Manual hold

4.2.6 Reporting screen(s)

4.2.6.1 View and print past runs

4.2.6.2 Database query and reporting

4.2.6.3 SPC reporting

4.2.7 Support screen(s)

4.2.7.1 Maintenance activities

4.2.7.2 Database configurations

4.3 Screens shall be easily modified by the user.

4.3.1 A screen design utility shall be provided.

4.3.2 Screen design shall be security lockable

5.0 Part Entry

5.1 Ability to enter information defining each part to be run in the cure cycle

5.1.1 Ability to enter and record multiple fields for each part:

5.1.1.1 Forty (40) fields per part (minimum)

5.1.1.1.1 Fields are user configurable

5.1.1.2 Model Number

5.1.2 Ability to select part attachments for each part entered:

5.1.2.1 Select thermocouples attached to the part

5.1.2.2 Select vacuum source lines attached to the part

5.1.2.3 Select vacuum probe lines attached to the part

5.2 Ability to select a part from a previously defined Part Database listing

5.2.1 System will automatically enter pre-defined field information

5.2.2 Ability to link a Recipe to each part database record

5.2.2.1 Ability for the software to will automatically select and load the linked Recipe upon part selection.

5.2.2.2 If linked Recipe does not match previously selected Recipe (earlier part entry), warning will be issued to the operator indicating incompatible part.

5.2.3 Ability to define for each part record photo and graphic (TC connection diagrams) files which will be automatically displayed to the operator upon part selection.

5.3 Ability to pre-batch parts for future runs.

5.4 Ability to print a batch report

5.4.1 Listing of all parts in load

5.4.1.1 Listing of all part fields

5.4.2 Listing of all attachments on each part

5.4.3 Printing of pre-run leak test results

6.0 Pre-run Integrity Checks

6.1 Prior to run commencement the system shall perform the following checks (user selectable and configurable):

6.1.1 Part Entry check

6.1.1.1 Software checks part database and confirms that each field is entered properly

6.1.1.1.1 Software confirms character count of specified fields (if configured)

6.1.1.1.2 Software confirms leading or trailing characters in specified fields (if configured)

6.1.1.2 Software confirms that unique fields are not duplicated (ie. serial number)

6.1.1.3 Software confirms that required fields are not blank (configurable)

6.1.2 Part Attachment check

6.1.2.1 Software checks part database and confirms that each part has the minimum number of thermocouples attached to it.

6.1.2.1.1 For each attached thermocouple, system confirms that the pre-run ambient temperature is valid (configured high/low limits)

6.1.2.2 Software checks part database and confirms that each part has the minimum number of vacuum source lines attached to it.

6.1.2.3 Software checks part database and confirms that each part has the minimum number of vacuum probe lines attached to it.

6.1.2.3.1 For each attached probe, system confirms that the pre-run vacuum level is valid (configured high/low limits)

6.1.3 Header check

6.1.3.1 Software checks that the vacuum header(s) are at a suitable level prior to draw-down and leak check commencement.

6.1.3.1.1 Configurable deviation from current vacuum setpoint.

6.1.4 Draw-down check

6.1.4.1 Software confirms that all probe readings are within acceptable deviation and stable prior to performing leak check.

6.1.4.1.1 Configurable deviation

6.1.4.1.2 Configurable stability time

6.1.5 Leak Check

6.1.5.1 Initial probe readings, air temperature, and pressure are recorded

6.1.5.2 Vacuum source lines are automatically isolated (OFF)

6.1.5.3 Software waits pre-configured time period.

6.1.5.4 Ending probe readings, air temperature, and pressure are recorded.

6.1.5.4.1 If probe readings changed more than pre-configured leak check deviation limit, an alarm is indicated.

6.1.6 Probe connect check

6.2 The results of each Integrity Check shall be able to be printed in report format.

6.3 Integrity Check reports shall be electronically saved to the run's datafile for post-run and future viewing and printing.

7.0 Equipment Control

7.1 System shall be capable of controlling the equipment without the need of a secondary PLC or setpoint controllers.

7.2 Software shall incorporate a high-level logic or script language allowing future modifications to equipment operations, including valve operation, interlocks, heater operation, and other related operations.

7.3 Software shall monitor all analog sensors (ie. thermocouples, transducers, etc.) as well as all digital input devices (limit switches, pressure switches, etc.)

7.4 Software shall capable of independently controlling all discreet devices, including pumps, motors, valves, and indicators.

7.5 Software shall provide closed-loop PID control of equipment temperature, pressure, and vacuum.

7.6 Software shall continuously read and monitor all sensors and inputs when in a run or when dormant. This is required for remote viewing and screen logging.

8.0 Recipe operations

8.1 Recipe creation

8.1.1 System shall support the creation and use of multiple recipe programs.

8.1.1.1 System shall be able to store and retrieve more than 200 recipes.

8.1.1.2 Recipes must be able to be stored locally or on a remote server PC.

8.1.1.2.1 If the server is not available, software must automatically load the locally stored recipe.

8.1.2 Recipe programs shall include the following information

8.1.2.1 Name

8.1.2.2 Description

8.1.2.3 Material specification

8.1.2.4 Permitted equipment (list of equipment that recipe can be used on)

8.1.2.4.1 Recipe retrieval will be disallowed on equipment that is not included in list.

8.1.2.5 Author

8.1.2.6 Created date

8.1.2.7 Modified date

8.1.2.8 Last run date

8.1.3 Revision creation and tracking shall be supported.

8.1.3.1 Ability to create a new program revision while retaining the old revision for record keeping purposes.

8.1.3.1.1 Old revision should be automatically locked from further operational use.

8.1.3.2 The revision # or letter shall be automatically incremented on creation of a new revised program.

8.2 Recipe programming

8.2.1 Recipes shall be programmed via a spreadsheet form.

8.2.1.1 Columns shall be discreet, programmed segments

8.2.1.2 Rows shall be cure cycle options and parameters

8.2.1.3 Pull-down listings shall be provided for commonly used entries.

8.2.1.4 One-click Help information must be provided for each row option

8.2.2 Recipe shall incorporate a flexible, programmable event-based system which will allow the following capabilities (Event or Watch groups):

8.2.2.1 Ability to control the progress of a cure cycle by entering sensor names (ie. AIRTC), event criterion (ie. >240), and actions (ie. GO).

8.2.2.2 Pull-down listing of available sensors should be provided.

8.2.2.3 Programmable event actions (minimum):

8.2.2.3.1 Wait (active at end of segment) based on the relative value of any sensor.

8.2.2.3.2 Hold (active throughout segment) based on the relative value of a sensor.

8.2.2.3.3 Alarm based on the relative value of any sensor.

8.2.2.4 Ability to define two event conditions that may be AND’d or OR’d to bring about a specific action.

8.2.3 Each segment shall include the following minimum parameters or programmable capabilities:

8.2.3.1 Segment Time

8.2.3.1.1 Ability to enter in seconds, minutes, and hours.

8.2.3.2 Temperature control

8.2.3.2.1 Control Thermocouple

8.2.3.2.2 Control Rate

8.2.3.2.3 Temperature Target

8.2.3.2.4 Cascade Parameters

8.2.3.3 Pressure Control

8.2.3.3.1 Control Rate

8.2.3.3.2 Pressure Target

8.2.3.4 Vacuum Control

8.2.3.4.1 Control Rate

8.2.3.4.2 Vacuum Target

8.2.3.5 Event or Watch Group #1

8.2.3.5.1 Sensor Name (ie. AIRTC)

8.2.3.5.2 Criterion (ie. >240)

8.2.3.5.3 Action (ie. GO)

8.2.3.6 Event or Watch Group #2

8.2.3.6.1 Sensor Name

8.2.3.6.2 Criterion

8.2.3.6.3 Action

8.2.3.7 Max Part Temperature (alarm)

8.2.3.7.1 Grace period

8.2.3.8 Min Part Temperature (alarm)

8.2.3.8.1 Grace period

8.2.3.9 Max Part Rate (alarm)

8.2.3.9.1 Grace period

8.2.3.10 Min Part Rate (alarm)

8.2.3.10.1 Grace period

8.2.3.11 Part Temp Delta Limit (alarm/control)

8.2.3.11.1 Control (On/Off)

8.2.3.11.2 Grace period

8.2.3.12 Load Temp Delta Limit (alarm/control)

8.2.3.12.1 Control (On/Off)

8.2.3.12.2 Grace Period

8.2.3.13 Temperature Float Limit

8.2.3.13.1 This energy-saving feature shall allow the equipment to adiabatically heat-up during pressurization while disallowing corrective cooling control.

8.2.3.14 Max Pressure (alarm)

8.2.3.14.1 Grace period

8.2.3.15 Min Pressure (alarm)

8.2.3.15.1 Grace period

8.2.3.16 Pressure Float Limit

8.2.3.16.1 This gas-saving feature shall allow the equipment to depressurize adiabatically during cooling while disallowing corrective pressure inlet control.

8.2.3.17 Bag-leak limit (alarm)

8.2.3.17.1 Grace period

8.2.3.18 Bag-pressure limit (alarm)

8.2.3.18.1 Grace period

8.2.3.18.2 Line Action (VENT or OFF)

8.2.3.19 Leak Test

8.2.3.19.1 Leak Test Time

8.2.3.19.2 Leak Test Deviation

9.0 Automatic run operations

9.1 Ability to start and stop a cure recipe cycle

9.2 Ability to Abort a cure cycle after a bag leak.

9.2.1 Software shall only allows abort below “precure” temperature limit.

9.2.2 Software shall automatically cool and depressurizes the equipment

9.2.3 Software shall continue to collect data

9.2.4 Software shall allow abort restart after parts have been

9.3 Ability to manually change segments

9.3.1 Change to next segment

9.3.2 Change to specific segment

9.3.2.1 Pull-down listing of segments

9.4 Ability to place run in a HOLD condition.

9.4.1 An intervention message must be logged to the alarm system.

9.5 Ability to change the data saving interval

9.5.1 Security lockable

10.0 Part Control

10.1 System must be capable of controlling the equipment process based on part temperature according to the following capabilities:

10.1.1 Ability to select in the cure recipe the specific thermocouple to be used for part control.

10.1.1.1 Any thermocouple (ie. Part TC #1)

10.1.1.2 Highest part thermocouple

10.1.1.3 Lowest part thermocouple

10.1.1.4 Average part temperature

10.1.2 Ability to modify the part control algorithm during the run.

10.1.2.1 Provide cascade or scaling parameters in Recipe

10.1.3 Ability to change the controlling thermocouple in each cure recipe segment.

10.1.4 Ability to control the maximum temperature delta across the entire part load by entering a load delta limit in the cure recipe.

10.1.4.1 Ability to change this delta limit in each segment.

10.1.5 Ability to control the maximum temperature delta across one part (one with highest delta) by entering a part delta limit in the cure recipe.

10.1.5.1 Ability to change this delta limit in each segment.

10.1.6 Ability to control the maximum air temperature – part temperature delta by entering a max air-part delta limit in the cure recipe.

10.1.6.1 Ability to change this delta limit in each segment.

10.2 System must be capable of controlling vacuum operations on each part according to the following minimum capabilities:

10.2.1 Ability to control the state of the vacuum lines during a programmed run.

10.2.1.1 Ability to select VAC, OFF, or VENT states for the vacuum lines.

10.2.2 Ability to perform a programmed vacuum leak test during the run.

10.2.2.1 System must record initial readings, disable all vacuum lines, wait a prescribed time, and then re-enable the vacuum lines.

10.2.3 Ability to program, per segment, a bag pressure limit above which the vacuum lines on the failed part will be automatically turned OFF or set to VENT.

11.0 Data-acquisition and archival

11.1 The system shall utilize individual datafiles for storage of run information.

11.1.1 Each datafile shall contain information from only one run

11.1.2 Datafiles shall be automatically named based on equipment name, date, and run of the day. (ie. AC4-120100-001.DAT)

11.1.3 Datafiles must be compact and portable

11.1.4 Datafiles must be easily transferred to diskette for data-sharing and archival purposes.

11.2 The following minimum information shall be stored on each datafile:

11.2.1 Recipe used during run

11.2.1.1 Recipe name

11.2.1.2 Entire recipe contents (spreadsheet)

11.2.2 Part information

11.2.2.1 All parts

11.2.2.2 All part fields

11.2.2.3 All attachment information

11.2.3 Integrity check reports

11.2.3.1 All reports shall be stored for future retrieval

11.2.4 Sensor information

11.2.4.1 Interval data of each sensor during run

11.2.4.2 Burst data at specific run events

11.2.4.2.1 Start of run

11.2.4.2.2 Segment change

11.2.4.2.3 Alarms

11.2.4.2.4 End of run

11.2.5 Alarm information

11.2.5.1 All system events and alarms

11.2.5.1.1 Time

11.2.5.1.2 Sensor

11.2.5.1.3 Alarm message

11.3 Datafiles shall be stored locally

11.4 Ability to automatically archive datafiles to server at run conclusion.

12.0 Run database system

12.1 Software shall create and maintain a run database

12.1.1 Database should be written at the start and end of each run.

12.1.2 Database shall include the following minimum information for each run:

12.1.2.1 Every part run in the equipment

12.1.2.1.1 Field information

12.1.2.1.2 Attachment information

12.1.2.2 Recipe name

12.1.2.3 Operator

12.1.2.4 Load number

12.1.2.5 User-defined SPC variables (ie. motor hours, cycle count, etc.)

12.1.3 A database analysis capability shall be provided

12.1.3.1 Analysis shall not require MS Access or MS SQL Server license on PC.

12.1.3.2 Ability to create and store queries for instant information retrieval

12.1.3.3 Ability to view and print database reports based on queries.

12.1.3.4 Ability to find and select datafiles based on database query.

12.1.3.5 Ability to create SPC charts.

13.0 Reporting system

13.1 A full-featured reporting system shall be provided.

13.1.1 Ability to view and select data from previously saved datafiles

13.1.2 Ability to view and or print batch report (parts) from datafile

13.1.3 Ability to select, view, and print Integrity Check reports for the run.

13.1.4 Ability to view and/or print trend report of data.

13.1.4.1 Trend display shall have the same capabilities as section 4.2.3

13.1.4.2 Ability to select sensors for report.

13.1.4.2.1 All sensors

13.1.4.2.2 Primary sensors (configurable)

13.1.4.2.3 Sensors on specific part

13.1.5 Ability to view and/or print numeric detail report of data

13.1.5.1 Ability to select sensors

13.1.5.1.1 All sensors

13.1.5.1.2 Primary sensors (configurable)

13.1.5.1.3 Sensors on specific part

13.1.6 Ability to view and/or print alarm and event log.

13.1.6.1 Color coded alarms

14.0 Quality inspection system

14.1 System shall have the capability of inspecting the run data based on comparisons to a pre-configured quality control document.

14.2 Quality document

14.2.1 Ability to create and edit a quality document for each part and/or specification

14.2.1.1 Create and edit quality inspection phases (ie. heating, soak, cooling)

14.2.1.2 Enter exception criteria for each phase, including high and low limits.

14.2.2 Ability to link the quality document to a specific part

14.2.3 Ability to link the quality document to a specific recipe

14.3 System shall generate the following quality reports.

14.3.1 Quality Summary

14.3.1.1 One report designed as a general quality report for each run.

14.3.1.2 Identify high/low sensor values at the beginning and end of each quality phase (ie. ramp, soak, depressurization)

14.3.1.3 Identify phase duration

14.3.1.4 Identify exceptions to temperature, pressure, vacuum, or time qualifications.

14.3.2 Quality Part

14.3.2.1 Inspects each part per that parts quality document.

14.3.2.2 One report for each part run in the load.

14.3.2.3 Identify high/low part sensor values at the beginning and end of each quality phase (ie. ramp, soak, depressurization)

14.3.2.4 Identify phase duration

14.3.2.5 Identify exceptions to temperature, pressure, vacuum, or time qualifications.

14.3.3 Exception Report

14.3.3.1 This report

15.0 Material modeling

15.1 Material modeling capabilities shall be included which will allow the software to determine material properties (ie. viscosity, glass-transition temperature, degree of cure, etc.) of a composite by utilizing real-time temperature feedback and a pre-defined material model.

15.1.1 Ability to utilize future, customer created models, without the need of Vendor's paid assistance or recompilation of software EXE.

15.1.1.1 Ability to utilize external, customer provided functions in the form of ActiveX DLL.

15.1.2 Ability to control the cure cycle based on the results of the model.

15.1.2.1 Event control based on level of viscosity, degree of cure, or Tg.

15.1.2.2 Event control based on the derivative (slope) of viscosity, degree of cure, or Tg

16.0 Maintenance

16.1 Screens

16.1.1 Ability for technician to customize any screen on the system to accommodate future demands.

16.1.1.1 A screen design utility must be provided for this purpose.

16.1.1.2 Screen designer shall be locked from most users.

16.1.2 Ability to create new screen(s) for future requirements.

16.2 Calibration

16.2.1 Ability to calibrate all analog readings

16.2.2 Ability to utilize high and low external standards for calibration.

16.2.2.1 Software to automatically calibrate reading based on comparison between technician entered Hi and Low values (ie. 0 and 100) and actual technician driven high and low values at the sensor.

16.2.3 Ability to calibrate any selected group of sensors at one time.

16.2.4 Ability to view and compare old and new calibration prior to accepting the new results.

16.3 Certification

16.3.1 Semi-automatic temperature certification

16.3.1.1 Ability for technician to enter temperature certification values (ie. 70, 250, 350)

16.3.1.2 Software to scan thermocouples (selected grouping) and automatically record acceptable in-tolerance values based on comparison of technician driven temperatures and the certification values above.

16.3.1.2.1 Tolerance shall be pre-configurable

16.3.1.2.2 Time stability shall be pre-configurable

16.3.1.3 At conclusion of process, system shall generate a certification report identifying the following minimum information.

16.3.1.3.1 Calibration personnel name

16.3.1.3.2 Standards used (ie. Fluke # 4560, Cal due: 12/20/01)

16.3.1.3.3 Tolerance and stability criteria

16.3.1.3.4 Results of certification of each sensor, including standard, value, tolerance, and pass/fail.

16.3.2 Automatic pressure certification

16.3.2.1 Ability for technician to enter pressure certification values (ie. 0, 100, 200)

16.3.2.2 Software to scan pressure transducer and automatically record acceptable in-tolerance values based on comparison of technician driven pressures and the certification values above.

16.3.2.2.1 Tolerance shall be pre-configurable

16.3.2.2.2 Time stability shall be pre-configurable

16.3.2.3 At conclusion of process, system shall generate a certification report identifying the following minimum information.

16.3.2.3.1 Calibration personnel name

16.3.2.3.2 Standards used

16.3.2.3.3 Tolerance and stability criteria

16.3.2.3.4 Results of certification of each sensor, including standard, value, tolerance, and pass/fail.

16.3.3 Automatic vacuum certification

16.3.3.1 Ability for technician to enter vacuum certification values (ie. 0, -10, -20, -25)

16.3.3.2 Software to scan vacuum transducers (selected grouping) and automatically record acceptable in-tolerance values based on comparison of technician driven pressures and the certification values above.

16.3.3.2.1 Tolerance shall be pre-configurable

16.3.3.2.2 Time stability shall be pre-configurable

16.3.3.3 At conclusion of process, system shall generate a certification report identifying the following minimum information.

16.3.3.3.1 Calibration personnel name

16.3.3.3.2 Standards used

16.3.3.3.3 Tolerance and stability criteria

16.3.3.3.4 Results of certification of each sensor, including standard, value, tolerance, and pass/fail.

16.4 Troubleshooting

16.4.1 Ability to force any individual I/O point

16.4.1.1 Security locked to Maintenance only

16.4.2 Provide electrical diagrams on-line

16.5 Maintenance database

16.5.1 Include a database to track and record maintenance operations.

16.5.1.1 Tracks operator entered problems and bugs.

16.5.1.2 Tracks maintenance operations.

16.5.1.3 Ability to query maintenance records based on person, item (ie. Inlet Valve), and problems.

16.5.1.4 Minimum fields

16.5.1.4.1 Date/Time

16.5.1.4.2 Name

16.5.1.4.3 Item

16.5.1.4.4 Problem

16.5.1.4.5 Solution

If you have any questions regarding this specification, please contact us.

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