

I/A Series[®] Software Spreadsheet

	b/h	b/h	prefra	actionator	b/h	
day	unitchg	deschg	bz oh m%	bz feed m%	bz recover	% recovery
	222.00	95.00	0.60	2.80	5.646	90.830
2	208.00	90.00	0.60	2.00	5 284	90.030
3	205.00	90.00	0.60	2.70	4 995	90.244
4	206.00	90.00	1 10	2 70	4 572	82 201
5	208.00	90.00	0.60	2.50	4,660	89.615
6	211.00	93.00	0.70	2.50	4 624	87 659
7	222.00	98.00	0.70	2.50	4 864	87 640
8	228.00	100.00	0.60	2.50	5.100	89.474
9	230.00	100.00	0.60	2.60	5.380	89.967
10	225.00	100.00	0.70	2.70	5.375	88.477
11	222.00	100.00	0.80	2.70	5.194	86.653
12	222.00	100.00	0.70	2.70	5.294	88.322
13	223.00	100.00	0.80	2.70	5.221	86.713
14	223.00	100.00	0.80	2.70	5.221	86.713
15	220.00	100.00	0.70	2.70	5.240	88.215
16	226.00	97.00	0.80	2.70	5.326	87.283
17	215.00	189.00	0.90	2.00	2.599	60.442
18	204.00	95.00	0.80	2.80	4.952	86.695
19	206.00	95.00	0.80	2.80	5.008	86.824
20	212.00	95.00	0.70	2.80	5.271	88.797
21	213.00	95.00	0.70	2.50	4.660	87.512
22	217.00	95.00	0.70	2.50	4.760	87.742
23	218.00	95.00	1.00	2.50	4.500	82.569
24	217.00	95.00	0.70	2.40	4.543	87.231
25	218.00	95.00	0.70	2.40	4.567	87.290
26	218.00	95.00	0.70	2.40	4.567	87.290
27	215.00	95.00	0.80	2.40	4.400	85.271
28	216.00	95.00	0.80	2.30	4.208	84.702
29	220.00	95.00	0.70	2.30	4.395	86.858
30	290.00	137.00	1.30	2.20	4.599	72.085
31	277.00	140.00	1.70	2.20	3.714	60.945
mean =	221.194	101.581	0.787	2.548	4.798	85.258
max =	290.000	189.000	1.700	2.800	5.646	90.830
min =	204.00	90.000	0.600	2.000	2.599	60.442

The I/A Series Spreadsheet is an interactive, easy-to-use tool, that allows process operators, engineers, and managers to manipulate data in a row/column format and graph the data for production control purposes.

Spreadsheet is a workstation-operated software package that allows you to perform row/column operations, including "what if" calculations. You can mix live process data and historical data with keyboard-entered data. You can display data in graphical form. You can use Spreadsheet to support production control functions such as:

- Energy balance calculations
- Process flowsheets
- Material balance calculations
- Inventory management

Spreadsheet can be a part of the I/A Series production control domain (see Figure 1). The information flow between Spreadsheet and I/A Series Industrial Software and Workstations is shown in Figure 2. Spreadsheet operates on an I/A Series Application Processor 20, or a personal computer configured to run I/A Series software. Spreadsheet allows you to:

- Read and write process variables via the I/A Series Object Manager.
- Read from and write to the system data base via the I/A Series Real-Time Data Base Manager.
- Read data from historical data bases via the I/A Series Historian.



- Calculate physical properties of steam and water via the I/A Series Physical Properties Library.
- Transfer spreadsheet data to application programs for processing and return results to the spreadsheet.
- Display data graphically (e.g., bar charts, histograms, pie charts).
- Print spreadsheet data via a line printer.

APPLICATION EXAMPLE

You can use Spreadsheet for "what if" calculations. For example, you can create a spreadsheet to help you find the minimum cost of running a system of three boilers that feed a common header to generate steam required for plant utilities (see Figure 3). You enter the total load demand, Boiler1 load, and Boiler2 load. Then you recalculate the spreadsheet to display the Boiler3 load and total cost for this input data run (see Figure 4). You make additional runs using other Boiler1 and Boiler2 loads to find the minimum total cost for the given total load demand. You adjust the load among the boilers by looking at the total cost, and the incremental cost for each boiler.



Figure 1. Spreadsheet Application Diagram



Figure 2. Spreadsheet Information Flow Diagram





RUN NO.	TOTAL LOAD DEMAND (klb/hr)	BOILER1 LOAD min=25 max=250 (klb/hr)	BOILER1 INCRE- MENTAL COST (\$/klb)	BOILER2 LOAD min=40 max=250 (klb/hr)	BOILER2 INCRE- MENTAL COST (\$/klb)	BOILER3 LOAD min=25 max=250 (klb/hr)	BOILER3 INCRE- MENTAL COST (\$/klb)	TOTAL COST (\$/hr)
1	600	180	3.02596	220	3.19702	200	3.14084	1777.59
2	600	190	3.04681	210	3.17234	200	3.14084	1776.10
3	600	200	3.06767	200	3.14765	200	3.14084	1775.08
4	600	210	3.08852	190	3.12297	200	3.14084	1774.50
5	600	220	3.10937	180	3.09829	200	3.14084	1774.39
6	600	230	3.13023	170	3.07361	200	3.14084	1774.72
7	600	190	3.04681	190	3.12297	220	3.17163	1776.27
8	600	195	3.05724	195	3.13531	210	3.15624	1775.54
9	600	225	3.11980	189	3.12050	186	3.11929	1774.12

Figure 4. Sample Application Spreadsheet

BASIC SPREADSHEET CAPABILITY

You select the Spreadsheet application from a menu in the I/A Series plant management or software development environment. Spreadsheet provides:

- Up to 32 767 rows by 19 688 columns (limited only by available disk space).
- Easy entry of data and formulas.
- Help facility to remind you of command usage or cursor movement.
- Input to one spreadsheet from the output of another spreadsheet.
- Simultaneous processing of several spreadsheets.
- Processing of spreadsheet data using operating system utilities.
- Ability to define macros for performing repetitive spreadsheet tasks.
- Built-in functions to speed development of a spreadsheet.
- Up to four windows to view different areas of the spreadsheet.
- Access to the operating system file system so you can send and receive information from the operating system environment.
- Access to graphics commands for creating graphic displays of spreadsheet data.
- Flexible report formatting that includes page numbers, headers, footers, line spacing, and automatic breakup of extra-wide spreadsheets into separate pages.

You can edit, delete, copy, move, or lock cell entries and recalculate a range of cells. You can easily insert new columns and rows into the spreadsheet. You can lock titles on the display as you scroll the screen to other areas of the worksheet.

There are many built-in mathematical, process engineering, and business functions—for example; summing, averaging, logarithmic, trigonometric, tablelookup, net-present-value, and loan-payment functions.

There are many formatting options for the spreadsheet data including decimal, scientific notation, percent, and dollar. You can write macros to save and recreate command and keystroke sequences for automating repetitive spreadsheet tasks.

When several spreadsheets are processed simultaneously, data from one sheet can appear in another. When this data changes in the first spreadsheet, it is automatically updated in the second spreadsheet.

Spreadsheet Layout

The spreadsheet consists of a contents line, entry line, and command line, followed by the worksheet which consists of a number of rows and columns (see Figure 5). The letters across the top of the worksheet designate the columns, and the numbers at the left side indicate the rows. Each box (cell) at the intersection of a row and column can store information—a number, letters, words, or a formula for calculating a number. The cell address is a combination of its row number and column number.

The contents line shows the address, contents, and format style of the cell you are in. The entry line displays the work you are currently doing in that cell. When necessary, the command line guides you for information to execute a command.



Figure 5. Spreadsheet Layout

Formulas

You can enter a formula into any cell. Operands in the formula may be any number, a cell address, or a built-in function, e.g., 7 + B3 + SUM(A1.C1).

If a new value is entered in a cell that is used in a formula, the formula automatically recalculates to the new value. When you place the cursor on the cell containing the formula, the contents line displays the formula, while the cell displays the results of the formula.

Spreadsheet recognizes a wide variety of arithmetic, relational, and logical operators (see Table 1).

Operator	Meaning
* *, ^	Raise to a power
* , /	Multiply, divide
+ ,-	Add, subtract
= = , ! =	Equal to, not equal to
< ,< =	Less than, less than or equal to
> ,> =	Greater than, greater than or equal to
&&	Logical and
"	Logical or

Table 1. Spreadsheet Operators

Cell Ranges

You can replicate, name, move, format, delete, and print a range of cells. A range can be a single cell, a partial row or column of cells, or a block of cells. A range is indicated by entering the coordinate of the upper left corner of the block and the lower right corner of the block, separated by one or more periods, e.g., D5..K13.

Menus

The commands to enter, edit, or manipulate data are listed in menus directly above the worksheet. The main menu connects to second-level menus, which may connect to third-level menus. Sometimes the menus lead to a prompt which ask you to select an option (e.g., yes or no).

Figure 6 shows the main menu with the options for the Edit command. Command line 1 lists the nine choices in the main menu; each one of these is a menu itself. Command line 2 describes the options that are available under the menu items above it. The current menu choice is highlighted (if your terminal has that capability).

As you move the cursor from item to item, the command line options change accordingly. You can select a command, move back one menu or quit the menus at any point.

Spreadsheet provides commands typically provided by spreadsheet software. Some of the functions that these commands allow you to perform are:

- Edit, delete, copy or move the contents of a cell.
- Change the format of a label or value in a cell.
- Lock a cell (to protect formulas from overwriting).
- Save the spreadsheet in a file.
- Delete and insert columns or rows.
- Recalculate the entire spreadsheet.
- Print the spreadsheet.
- Enter data from a UNIX file into a spreadsheet.

CONTENTS LINE						
ENTRY LINE						
/						
COMMAND LINE 1						
Edit Cell Files Worksheet Global options Print UNIX access Options	Quit					
COMMAND LINE 2						
Edit: Cursor motion: <>, Delete Right: ^N, Return: cr						

Figure 6. Main Menu

EXTENDED SPREADSHEET CAPABILITY

Spreadsheet provides extended capability—beyond the typical spreadsheet commands.

Options Menu Commands

The Options menu commands are:

- Historian
- Database

Historian allows you to:

- Read values of process variables over a time period from an Historian reduced data group into a spreadsheet.
- Display a list of Historian group identifications and descriptions for a specific Historian.

Database access allows you to:

- Read data values from an application data base into a spreadsheet.
- Insert data values from a spreadsheet into an application database.
- Update data values in an application data base with data from a spreadsheet.
- Delete existing data values in an application data base from a spreadsheet.

Reading and Writing Process Variables

You can access process variables (global variables) in the Control and I/O data base by using Object Manager functions as spreadsheet formulas. These global variables are either compound/block parameters or shared variables created by I/A Series or user-written application programs. Object Manager is the software interface between Spreadsheet and a Control Processor. You simply enter the desired function call statement—e.g., o—getv (variable name) to bring a process variable value into the spreadsheet. You can use the following Object Manager functions:

o_getv o_setv o_readv o_wrtev

o_getv reads a process variable value into the spreadsheet—single operation access.

o_setv writes a process variable value from the spreadsheet to the Object Manager—single operation access.

o_readv reads a series of process variable values into the spreadsheet in vertical or horizontal order.

o_wrtev writes a vertical or horizontal series of process variable values from the spreadsheet to the Object Manager.

Using Physical Properties Library

You can access the Physical Properties Library as spreadsheet formulas to perform calculations on spreadsheet data. You simply enter the function call statement, e.g., vpt_stm(p,t) where p and t are the required input parameters, to calculate the volume of steam. You can use the following library subroutines:

vpt_stm hpt_stm spt_stm

pt_sw vpt_wtr htp_wtr spt_wtr

vpt_stm calculates steam volume as a function of steam pressure and temperature.

hpt_stm calculates steam enthalpy as a function of steam pressure and temperature.

spt_stm calculates steam entropy as a function of steam pressure and temperature.

pt_sw calculates steam/water saturation pressure as a function of temperature.

vpt_wtr calculates water volume as a function of water pressure and temperature.

hpt_wtr calculates water enthalpy as a function of water pressure and temperature.

spt_wtr calculates water entropy as a function of water pressure and temperature.

USING MACROS

Macros are scripts that you create for performing repetitive spreadsheet tasks. A macro is a string of keystrokes contained within a cell, or a sequence of cells within one column. Macros use certain keywords, e.g., "up" and "if". Spreadsheet allows you to:

- Name a cell containing a macro.
- Write macros for looping and conditional execution.
- Write macros that call other macros as subroutines—nested macros.
- Take information contained in any cell and substitute it anywhere in the macro string.
- Write macros to create menus that function much like the command menus.
- Program the CR key to call another macro for speeding up data entry when using a template.
- Write macros to automate Spreadsheet graphics or print commands.

BUILT-IN FUNCTIONS

Spreadsheet has many built-in functions which you can use as part of formulas. These functions include:

- Read a process variable value.
- Write a process variable value.
- Read a series of process variable values.
- Write a series of process variable values.
- Steam volume.
- Steam enthalpy.
- Steam entropy.
- Steam/water saturation pressure.
- Water volume.
- Water enthalpy.
- Water entropy.
- Sum.
- Average value.
- Square root.
- Absolute value.
- Natural logarithm.
- Log base 10.
- Sine.
- Cosine.
- Arc-cosine.
- Arc-sine.

- Arc-tangent.
- Value of e (2.7182818) to a power.
- Greatest integer smaller than a number.
- Count of arguments in a list.
- Largest value in a list.
- Smallest value in a list.
- If A is non-zero, return B, else return C.
- Time since 12:00:00AM January 1, 1970.
- Day of the month.
- Day of the week.
- Month of the year.
- Year of the century.
- Hour of the day.
- Value of argument x where x is the value of the key.
- Uses the key to look up a value in the column and returns a corresponding value in the offset column.
- Uses the key to look up a value in the row and returns a corresponding value in the offset row.
- Not available (NA) note.
- ERROR note.
- Return 1 (TRUE) if the cell is NA, otherwise return 0.
- Return 1 if the cell contains an ERROR note, otherwise return 0.
- Return 1 if the cell is empty.

GRAPHICS FUNCTIONS

Spreadsheet provides the following graphics utilities:

- Bar chart
- Pie chart
- Line graph
- Histogram
- Scatter chart
- · Organization chart

Numerous options allow you to be flexible in designing charts. You can control: titles and legends, grid and frame styles, colors and patterns, line and symbol types, and horizontal or vertical formats. These graphics commands are also available outside of the Spreadsheet environment.

Spreadsheet graphics utilities allow you to:

- Use multiple windows to present several graphs at once.
- Extract data from within the spreadsheet and send it to any of the graphics commands or redirect it to a file.
- Send the output from the spreadsheet directly to the Pie, Hist, Scat, and Chart graph commands.
- Reformat the spreadsheet data with the Invert command before sending the data to the Bar and Lgraph graphs commands.
- Direct the output of these graph commands to files for display or printing at a later time.

- Enter the graph commands at the operating system shell level.
- Plot and draw graphs on a computer screen or line printer—using color or black and white.
- Store graph commands in executable files known as shell scripts—that allow you to create templates as part of an application program.
- Switch between output devices by simply changing the operating system environment shell parameter GTERM.
- Write operating system shell scripts using the graph commands to build graphics for your application, independent from Spreadsheet use.

Figure 7 illustrates each type of graph.

Color

Color options allow flexibility and control over colors for every part of a chart. If you have a color monitor, you will be able to display all your graphs in living color. The coloring options vary according to graph type.

Spreadsheet graphics support I/A Series workstation displays in addition to several color monitors and hard-copy output devices. The number and variety of colors available on a terminal screen are hardwaredependent.

SPECIFICATIONS

Configuration and Size

NUMBER OF ROWS 32 767 NUMBER OF COLUMNS 19 688 TOTAL ENTRIES 32 767 x 19 688 MAXIMUM CELL WIDTH 128 characters DEFAULT CELL WIDTH 9 characters MAXIMUM NUMBER OF CHARACTERS PER CELL NAME 7 NUMBER OF VARIABLE SIZE COLUMNS 256



Figure 7. Sample Graph Charts

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