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MARTIN MARIETTA

OPERATOR'S MANUAL FOR THE MULTISTATION OFFGAS ANALYSIS SYSTEM

A. B. Hayes, J. A. Basford
Instrumentation & Characterization Department
Development Division

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OPERATORS MANUAL FOR THE MULTISTATION OFFGAS ANALYSIS SYSTEM

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1. INTRODUCTION

Purpose:

The Multistation Offgas Analysis System (MOAS) is a fully automated instrument which can independently measure the gases emitted by up to four samples in containers heated in ovens. A mass spectrometer is used to determine accurately their flow rates. There are six interconnected high vacuum pumping stations, one for each of the sample containers, one for the mass spectrometer, and one for the calibrated leaks which are used to calibrate the mass spectrometer. Quadstar 421™ is the software package marketed by Balzers, the manufacturer of the mass spectrometer.

This software used by MOAS is a combination of Quadstar 421™, special routines, called sequences in the Balzers nomenclature, and compiled programs that control MOAS. Tests are run repeatedly on each of the four oven stations, while stations that are not ready, or do not have a sample are skipped. While the computer is sitting idle between tests, the software monitors the vacuum system. If necessary, the software will shut down a pumping station that is not operating correctly. The status of pumping stations and tests, filenames for data and oven temperatures are stored on disk, so the software can recover from a power failure.

Different oven temperature profiles can be selected for each oven, and the ovens can be calibrated separately. In the event of a power failure, the oven controllers do not resume where they left off in the temperature profile. Instead, they set the temperature according to elapsed time from the start of the test. This elapsed time includes time 'lost' in a power failure. No attempt is made to recover test data points missed during the power failure.

The operator can use the software to start or stop testing, load parts, perform calibrations as necessary, and start up or shut down pumping stations. The software aids in routine functions, such as changing an ion gauge, by performing the required valve actuations automatically, and checking the pressure readings and turbopump speeds as necessary.

The computer takes mass spectrometer sensitivity calibration data automatically, every week at 12:00AM on Sunday. An operator does not need to be present for these calibrations. The calibration data are saved and may be used or deleted by the operator at a later date.

Power failure recovery:

When the power is restored to the computer and the vacuum systems after a power failure, stations that were running normally before the power failure are restarted. If a

station was shut down before the power failure, or was in some abnormal state (e.g. the ion gauge was being changed), that station would not be automatically restarted. Every station that was testing before the power failure will resume testing, if possible.

2. STARTING THE SOFTWARE FOR THE FIRST TIME

If the software was previously running on a simulated test system, be sure that the software knows that all six pumping stations are shut down. The software can be run in simulation mode to accomplish this. Refer to the Quadstar 421TM manual for more information on the simulation mode. This will prevent the computer from assuming that a power failure occurred and starting the stations without initial rough pumping by the mechanical pumps.

Refer to the manual "Software for the Multistation Offgas Analysis System" if the software has not already been properly set up. Once the software is loaded and the macro routine is set up, verify that the macro recorder launches the software properly. This should be done by re-booting the computer. This way, the software can only be left running if it is correctly set up for power failure recovery.

Do not start the software by running any sequence other than the one called by the macro. (Refer to the "Software for the Multistation Offgas Analysis System" manual.) The software will not function properly if it is not started properly.

After the startup sequence finishes loading data, the prompt "Press ENTER now to go to main menu." will appear. Press ENTER while this prompt is up and the main menu should appear after a few seconds. If it does not appear, the enter key probably was not pressed quickly enough. Wait for the prompt to reappear and press ENTER right away.

Once the main menu is displayed, refer to the section on "Starting a station" to start stations 0 through 5 individually. This is the only time the stations will need to be started individually. Once the stations are running properly, they will all be restarted after a power failure automatically.

3. THE MAIN LOOP

How to get to the main menu:

to the main menu." is displayed several times. After several seconds, the prompt disappears temporarily. While the prompt is displayed, pressing enter, or the space bar, or

clicking on "OK" with the mouse will cause the main menu to be displayed. For information on the main menu, look up the desired function (e.g. Starting a station) in this manual.

Functions performed in the main loop:

After the menu prompt is displayed four times, the sequence performs routine functions such as checking over the system for problems, checking to see if it is time for the weekly calibration, and running a test if one of the oven stations is ready for a test.

4. TEST INFORMATION

How to begin testing a part:

1. Choose the station to be used (1,2,3, or 4), and be sure it is not testing. (Refer to the section on "Checking the test status".) If a part is still installed on that station, refer to the section on "Removing the sample container".
2. Install the sample container on the station.
3. Pump down the sample container. Refer to the section on "Replacing the sample container."
4. Start a test. Refer to the section on "Starting a test".

Test data:

Note: Do not delete the test data file, or the temperature data file, or rename either one, while the test is still running. Doing so, will cause the computer to stop and wait for a user to click "OK" during the next two test cycles for that station.

During testing, several messages appear at the bottom of the screen in the status bar. These messages tell what part of the test is being performed. In order to test on a station, the following conditions must be met:

The station must be running a test.

The station's status light must be on.

The station must be running in a normal mode (i.e., the station may not be in the middle of an ion gauge change and must be running under high vacuum).

Stations 0 and 5 must be running normally with their status lights on.

Pressure limits for the testing station, as well as stations 0 and 5, must be met.

Station 0 must not be in the middle of a filament change.

Once a test has started, the following data are taken:

A background scan is taken before the station is connected to the mass spectrometer. This scan is stored in a file called BACKGR0#.MDC, where # is the station number.

A scan is taken after neon gas is admitted into the mass spectrometer chamber from the neon calibrated leak. The scan is stored in a file called NEON000#.MDC.

Valve #5 is then opened, and the data from the sample offgas are stored in a file called *.MDC, where # is the filename entered in the "Start Test" menu, when the test was started.

Finally, the temperatures are recorded for each station that is running a test. The temperature is stored in a file called *T.MDC, where * is the filename entered in the "Start Test" menu.

The neon and background data files may be deleted or renamed after each test is finished, since data from future tests get appended to the same file, if it exists.

Note: The data stored in the file whose name is given by the user to start the test, and the data in the temperature file have two invalid data points (cycles) each. When the file is created, two data points are written using phony data. These points are needed, so that program does not hang up while displaying a "File too small" message. The first two points should not be used in the analysis. The neon data and the background data do not have any excess data.

5. USING THE SOFTWARE

Starting a station:

To start a station that has been shut down, use the following procedure. Do not use this procedure to pump down after an ion gauge change, or a mass spectrometer filament change, or after installing a new part for testing. There are separate procedures for those operations.

In the main menu, select "Station/Sample". A dialog box will appear asking for a station number. Click once on the station number. At the next dialog box, select "Startup" by clicking on it once. The computer will attempt to start the desired station, if it has actually been shut down. If the computer sees that the station is actually running, then no action will be taken. This method of starting the station works whether the station has been left evacuated, or it has been exposed to air.

If the station selected is one of the oven stations, the computer may ask whether the sample container is attached. If the user responds by clicking "Yes" and there really is not any sample container attached, valve #6 will open and flood the station with air, possibly causing serious damage.

The computer will now finish pumping down the station, and monitor the station periodically. If the station started was an oven station that was running a test before it was shut down, the test will automatically be resumed.

Shutting down a station:

Do not use this routine to prepare to change an ion gauge, the mass spectrometer filament, or a part in the sample container. There are routines designed specifically for those purposes. See the appropriate sections in this manual.

To shut down a station, select "Station/Sample" in the main menu. In the dialog box titled "Select Station Number" click the appropriate number. Select "Shutdown" at the next menu. The selected station will be shut down, closing the appropriate valves, stopping the mechanical and turbomolecular pumps and opening the vent valve. The station will not be restarted after a power failure once it has been shut down manually.

Although tests cannot be performed on an oven station if the station is shut down, the testing will resume on that station once it is restarted. While the station is shut down, oven temperatures will continue to be taken at regular intervals, so the profiles can be followed.

If either station 0 or 5 is shut down, no testing will be performed on any station until both stations are running again. However, temperatures will still be recorded at regular intervals.

Removing the sample container:

Do not shut down the station to replace the container. This is unnecessary and exposes the vacuum system to air.

If it is necessary to remove the sample container, the test, if one is running on the station, must be interrupted, or stopped. If it is interrupted, it may be restarted but if it is stopped, it cannot be restarted. Although the oven will be set to the correct temperatures while testing is interrupted, temperature data and test data will not be recorded.

To remove the sample container, click on "Station/Sample" at the main menu. When the "Select Station Number" menu appears, select the station number. At the next menu, select "Remove Sample". Wait for a message indicating that the sample can be removed safely. If such a message does not appear, or if an error message appears, do not remove the sample. An error will appear if the station is testing.

Replacing the sample container:

After attaching the sample container to the vacuum system, click "Station/Sample" in the main menu. Select the station number at the next menu. When the next four choices appear, select "Pump on Sample."

The computer will ask for confirmation that the container has been properly attached. Be sure that the sample container is properly attached before answering "Yes", or press "Cancel" if necessary. If the sample container is not attached properly, the station will be flooded with air and will not pump down properly.

Once the computer gives an ok message, a test may be started. If an error is given re-install the sample container and try again. This function is not allowed during a test, since the "Remove Sample" function is also disabled.

Starting a test:

After installing a sample container on the station and evacuating it, (See "Replacing the sample container".) a test may be started on that station.

In the main menu, select "Start Test". When the next menu comes up, choose the station number. In the "Profile Name" menu, choose one of the six temperature profiles. In the "Filename" menu, type a file name of 7 characters or less. It is very important that the name is not more than 7 characters, because the temperature data file requires the 8th character. The name must not include a period or extension. The extension is supplied automatically by the software.

Once the information has been entered, a dialog box will appear and ask for confirmation. Make sure that the correct choices were made and that the file name fits the requirements given in this section. Press "No" to change the information, "Cancel" to abort the test, or "Yes" to begin with the test.

Wait for the message "Starting" to appear. This indicates that the computer was able to start a test on the selected station.

Pausing / resuming a test:

If it is necessary to interrupt a test, the "Pause test" button in the main menu may be clicked. The same button is used to resume a test. When a test is interrupted, no outgassing data are taken, and the temperature of the oven is not recorded until the test is resumed. The temperature profile is followed normally.

Stopping a test (permanently):

By selecting "Stop Test" in the main menu, a test can be stopped permanently. Once the station number is given by the user, a dialog box asks for confirmation. If the station number is confirmed, the test is stopped, and the temperature profile is aborted. The oven is shut off by Quadstar 421™.

Once a test is stopped, it can be restarted from the beginning, but the temperature profile will not be resumed where it left off. Extra data points may be taken by "Resuming" the test, but the oven will be shut down anyway. To stop taking data temporarily but keeping the oven temp. profile running, see "Pausing / resuming a test."

Mass scale calibration:

Calibration of the mass spectrometer's mass scale is needed infrequently to assure that the only the tops of the peaks are used for data acquisition. It should be performed whenever the filaments have been replaced or when the ionizer voltages have been changed. Carefully follow the Balzewrs mass spectrometer manual for these two procedures.

To perform a mass scale calibration, select "Mass Scale Calibration" in the main menu. The computer will prompt the user once again to make sure, because the calibration may take several minutes. The calibration may also affect the data taken afterward. For more information on the mass scale calibration, refer to the Quadstar 421™ manual.

Changing an ion gauge:

It is not necessary to stop or pause testing on an oven station before changing an ion gauge. Do not shut down a station when changing an ion gauge. Instead, use the "Ion Gauge" button in the main menu. When the next dialog box appears, select the station

number. When the "Remove or Replace" dialog box appears, click "Remove". The computer will ask for confirmation.

The station will be left running, but valves will be closed to isolate the ion gauge. Testing will be temporarily interrupted on that station if it is an oven station. If the gauge on station 0 or 5 is being changed, testing on all stations will be interrupted until the gauge is replaced. Temperature data will be recorded on each of the four oven stations that have temperature profiles and tests running regardless of which station is having a gauge replaced.

Only when the computer displays a message saying that the gauge may be removed is it safe to do so.

After replacing the gauge, select "Ion Gauge" again in the main menu. Select the same station number and click "Replace". Be sure the gauge is installed correctly and answer the questions that appear.

The computer will evacuate the station and resume normal operation. If a test was running on that station, taking of data will resume.

Changing the mass spectrometer filament:

Do not shut down station 0 to change the mass spectrometer filament. Instead, select "MASS SPECTROMETER Filament" in the main menu. The computer will isolate the mass spectrometer chamber, then give a message indicating that the filament can be replaced safely. Since no testing can occur without the filament, this routine waits for the maintenance to be completed by the operator while monitoring the other five stations for proper operation.

Be sure that the filament is correctly installed according to instructions in the Balzers mass spectroemter manual and that the flange is sealed before telling the computer to procede with the pumpdown.

Once the filament has been replaced, and the flange is tight, respond to the flashing "Press ENTER..." prompt. This prompt behaves like the main menu prompt. There is a dialog box that asks for confirmation, in case the operator has responded prematurely.

Once the operator confirms the decision, the computer starts pumping down the mass spectrometer. A message is given when the process is complete. If a serious problem is found in the mass spectrometer station, that station will be shut down and must be restarted once the problem is corrected.

Manual control of valves, pumps, leaks and heaters:

Warning: Although the computer may prompt the user to confirm each valve or pump change, the computer will not override any change that may cause damage to the system. It is left to the operator to use caution.

Note: Do not leave the computer displaying the manual control windows for long periods of time. The computer can neither take data nor monitor the vacuum system while any dialog box is showing.

Before using the "Manual Control" function, be sure that the same task can not be accomplished using an automatic sequence, such as "MASS SPECTROMETER Filament", or "Ion Gauge".

To gain manual control of the system, select "Manual Control" in the main menu. Enter the password at the next prompt. After the password is entered, the operator may choose to be prompted for confirmation before each valve or pump change is made. If "No change" is selected by pressing ENTER, the selection from the previous time is repeated. This default resets to "Yes" if the software is shut down.

Next, select a station number. The heat tapes for all 6 stations are in a separate menu.

The buttons in the valve screens act as toggles. The state of the valve or pump must be known before changing its state. Both the computer screen and the status display panel show are lighted when a valve is open or a pump is running. When the mechanical pump on a station is running, valve 1, the vent valve, on that station is closed.

Once changes are completed on a station, the user may be asked if the station status should be set to "ignore". To follow the computer's suggestion, press enter for the default. If a station is set to "ignore" the computer will not monitor it for problems and no testing will be performed on that station. If station 0 or 5 is set to "ignore", no testing will be performed at all and the ion gauge will be turned off automatically. The gauge must be turned on manually on the gauge controller.

Since the stations that are set to "ignore" are not monitored, problems are more likely to cause damage. The station should be returned to its normal operating mode as soon as possible. This must be done manually.

If station 0 is set to "ignore", the operator may decide whether the mass spectrometer filament is to be left on, or off.

In order to set a station back to "monitor", when it has been set to "ignore", enter the menu for that station and operate the valves and pumps if necessary. Pressing "Quit" will cause the computer to display the "Ignore/Monitor" box again.

Normally, the computer will shut down a station if a turbopump fails, or if the pressure of a thermocouple gauge exceeds its set point. The station may be set to "ignore" so that the computer won't shut down a station whose turbopump or mechanical pump has been shut down manually, for example.

Locking the main menu:

Selecting "Lock" in the main menu will turn on the lock. If a user tries to get to the main menu, a password prompt will appear. The password must be entered correctly. Once the password has been entered, the lock is disabled until the "Lock" button is pushed again.

If the computer is reset, or the software is shut down, the lock will be disabled when the software restarts.

Changing the password:

The password may be changed at any time by selecting "Password" in the main menu. First, the old password must be entered. Then a new password must be entered twice. If the same password is entered both times, and the number entered is between 1 and 999,999, the new password will be accepted.

Checking the digital input status:

The status of digital inputs may be tested by selecting "DI Status" in the main menu. Upon selecting a set of digital inputs, their status is displayed. The status screen is not updated until the user selects "Update", regardless of changes in the digital inputs.

Checking the test status:

The status of testing may be checked on all four oven stations by selecting "Test Status" in the main menu. Once the status is displayed, it is not updated until "OK" is clicked and "Test Status" is selected again.

Under "Testing?" the words "Yes", "No", or "No sample" appear. "No sample" indicates that the sample container is not in place, or has not been evacuated after installation.

To start a test, or to evacuate a sample container after installation, see the appropriate section above.

6. AUTOMATIC SENSITIVITY CALIBRATION

Every week on Sunday at 12:00AM, sensitivity calibration data are taken automatically. This time was picked because the calibration ties up the computer for about two hours. There will thus be a two-hour gap in test data at this time every week.

Background scan data (i.e., with no leaks open) are stored in a file called SENSITI.MDC. Following the background scan, a scan is taken with each of a series of calibrated leaks open, and recorded in the same file. The leaks used may be found in the program.

The SENSITI.MDC file is appended with new data each week. The file does not need to be renamed every week. However, if the file gets too large, it can not be loaded by the Display Saved Values program and the data will not be accessible. For this reason, it is safest to rename the SENSITI.MDC file every week.

7. STOPPING THE SOFTWARE/ SHUTTING OFF THE COMPUTER

If it is necessary to shut down the computer or to stop the Quadstar 421TM software, the following procedure should always be used. To avoid loss of data and to ensure that the computer has time to record correctly the data used in power failure recovery, perform the following steps in the order they are given.

Please read the following procedure completely before attempting to stop the operation of Quadstar 421TM programs.

1. When the "Press ENTER to go to main menu." prompt appears, press ENTER and wait for the main menu to appear. Quadstar 421TM will not try to write any data to disk while the main menu is visible.
2. Wait one full minute to ensure that Quadstar 421TM and all of its associated programs have had time to update the necessary files.
3. Press ESCAPE and release. Immediately after pressing ESCAPE, press ALT-F. This should be done very quickly after pressing ESCAPE, so that the prompt for the main menu does not reappear.
4. Click on "Close", or press ENTER, if "Close" is already highlighted. The Quadstar 421TM sequences have now been terminated.

5. Return to the Windows Desktop, so the following icons are visible: Oven 1, Oven 2, Oven 3, Oven 4, Power Failure Data Storage, and Timer for Weekly Calibration. One at a time, open the icons by double-clicking on them. Once each program window comes up, press "q". If the program does not shut down, hold down the "q" key until it does. Once all six of these programs are shut down, the software has been properly stopped without any loss of data. The Quadstar 421™ software may be restarted in the Measurement program, by selecting "Sequence" and Execute" and then selecting "STARTUPI.SEQ". Be careful to always start the software using STARTUPI. The six icons listed above will also need to be restarted, since Quadstar 421™ can't run properly without them. They can be found in the "Startup" group. An easier way to restart the software is to exit Windows and then and restart it.

8. ERROR MESSAGES

Note: The "Emission off." error indicates that the filament in the mass spectrometer was probably turned off. There is a possibility that the filament was actually working. The error only serves as a warning.

The error messages that are preceded by a "W" or an "F" are generated by Quadstar 421™ and can be found in the Quadstar 421™ manual. Messages preceded by a "U" are generated by the MOAS-specific sequences and are described below.

The first word in the error message is the name of the Quadstar 421™ sequence that generated the message. Following the sequence name is the error message.

"Filament - Leak in the MASS SPECTROMETER chamber." Station 0 could not be pumped down after changing the MASS SPECTROMETER filament. This error results in shutting down station 0.

"Filament - Turbopump failed on station 0." The turbopump shut down and could not be restarted.

"Massi - Station 0's pressure is too high." The pressure was too high to do a mass scale calibration.

"Massi - Station 5's pressure is too high." The pressure was too high to do a mass scale calibration.

"Massi - Emission off." The filament may not have been turned on. An attempt was made to turn the filament on again. This error did not cause the calibration to be aborted.

"Massi - Status light for station 0 and/or 5 is off." This error caused the calibration to be aborted.

"Massi - Station 0 and/or 5 not running." This error caused the calibration to be aborted.

"Newgauge - Turbopump failed on station # ____." The turbopump failed and the station had to be shut down.

"Newgauge - Could not pump down on new ion gauge on station # ____." The station had to be shut down.

"Replace - Station # ____ has a leak." While pumping down on the sample container a leak caused the station to be shut down.

"Replace - Could not pump down on the sample on station # ____." The pumping process on the sample container was aborted, but the station was not shut down.

"Sensiti - Pressure in station 0 too high." The pressure was too high to do a sensitivity calibration.

"Sensiti - Pressure in station 5 too high." The pressure was too high to do a sensitivity calibration.

"Sensiti - Emission off." The filament may not have been turned on. An attempt was made to turn the filament on again. This error did not cause the calibration to be aborted.

"Sensiti - Status light for station 0 and/or 5 off." The calibration could not be performed.

"Startsta - Turbopump failed on station # ____." The pump failed and the station could not be started back up.

"Startsta - Could not pump down on station # ____." The station's pressure would not reach the set point in time. The station had to be shut down.

"Startsta - Station # ____ has a leak." The station's pressure would not reach the set point in time. The station had to be shut down.

"Startupi - Turbopump failed on station # ____." The pump could not be started after a power loss. The station was shut down.

"Startupi - Could not pump down station # ____." The pressure would not reach the set point in time, and could not be restarted after a power loss.

"Testi - Station 0 and/or 5 not running, or status light off." No test data could be taken during a test cycle. Temperature data may have been recorded anyway.

"Testi - IG # ____ pressure too high or gauge is off." The part in the station, whose number is given, could not be tested, because the pressure limit assigned in the TESTI.SEQ sequence was exceeded.

"Testi - Emission off." The emission may have been turned off. An attempt was made to turn on the filament, and data were taken anyway.

"Watch - Thermocouple 1 reading too high on station # ____." The station was shut down because the thermocouple gauge set point pressure was exceeded.

"Watch - Thermocouple 2 reading too high on station # ____." The station was shut down because the thermocouple gauge set point pressure was exceeded.

"Watch - Turbopump speed too low on station # ____." The station had to be shut down.

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A. B. Hayes
324 Kimball Drive
Rochester, NY 14623