INL/EXT-07-12458

AGR Fuel Development - Coater and Control System Upgrade

Douglas W. Marshall
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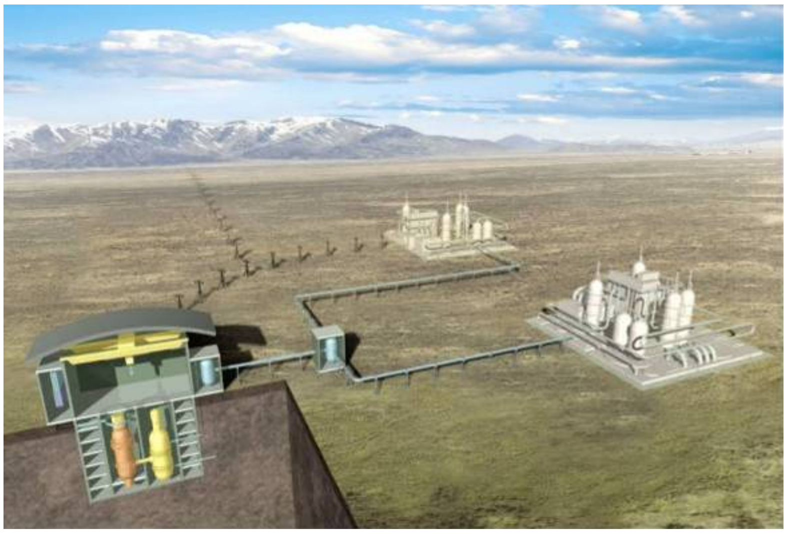
March 2007



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Next Generation Nuclear Plant Project
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Acronyms

AGR	Advanced Gas Reactor
BWXT	BWX Technologies, Inc.
CFD	computational fluid dynamics
gph	gallons per hour
HCl	hydrogen chloride
ID	inside diameter
IPyC	inner pyrolytic carbon
MTS	Methyltrichlorosilane
NPT	national pipe thread
NUCO	natural (enrichment) uranium oxycarbide
PID	proportional-integral-derivative controller
PLC	programmable logic controller
PSD	power spectral density
psig	pounds per square inch gage
SiC	silicon carbide
slpm	standard liters per minute
TRISO	tri-structural isotropic

AGR Fuel Development – Coater and Control System Upgrade

1. Introduction

BWX Technologies Nuclear Products Division (BWXT) is under contract[1] to fabricate 425-µm natural-uranium oxycarbide (NUCO) kernels and test 6-inch diameter nuclear particle coater designs for the Advanced Gas Reactor (AGR) program as part of an effort to "reestablish and demonstrate coated-particle fuel fabrication capability in the United States".[2] Tri-structural isotropric (TRISO) fuel coating technology has not been employed in the domestic production of nuclear fuel since the cessation of Fort St. Vrain fuel production in 1985. The effort to reestablish the technology in a near-industrial scale coater has necessitated upgrades to the existing BWXT coating system; including modifications and upgrades to the coater furnace, gas supply, off-gas handling, and the process control systems and instrumentation.

2. Feed Systems Upgrade

2.1 Methyltrichlorosilane System

The former methyltrichlorosilane (MTS) system was sized for use with the 2-inch diameter nuclear fuel coater that had been used for fuel coating process development studies. It was a design by TevTech, LLC., that incorporated a variable surface area vaporizer and a mass flow controller with a target mass flow of 1.7 gm MTS/min. Hydrogen sweep gas and carrier gas streams were independently controlled to attain the desired MTS mass flow and concentration in the hydrogen carrier at a nominal value of 1.5 vol%.

The system was rebuilt in accordance with a TevTech, LLC., design to accommodate larger variable-area vaporizer, gas lines, and mass flow controllers to achieve a nominal MTS flow rate of 42 gm MTS/min (14 – 70 gm/min range) and to handle the associated hydrogen gas flows.

Sierra gas detectors were also replaced with MSA detectors and set to alarm if the HCl or hydrogen concentrations in the flame cabinet exceeded set points of 2 ppm and 1 vol%, respectively.

2.2 Gas Supply and Feed Systems

The 6-inch coater was designed to have two independently controlled gas flow paths; one to supply non-reactive gas to an annular orifice that surrounds the gas injector and another to supply the coating gases to the injector distributor. This increased the number of gas flow controllers (by one) that were needed to control the flow of argon and hydrogen to the annulus.

New flow controllers were purchased to handle the following flow rates:

Argon:	0-600 slpm for the central gas flow and 0-150 slpm for the annulus
Hydrogen:	0-700 slpm for the annulus
Acetylene:	0-600 slpm at 5 psig delivery pressure
Propylene:	0-300 slpm at 5 psig delivery pressure

The acetylene storage capacity was doubled to accommodate 24 gas cylinders and the gas manifold was replaced with a high-flow manifold. Storage and flow capacities of the argon, propylene, and hydrogen gases did not need modification beyond replacing the flow controllers.

3. Furnace Upgrade

3.1 Furnace Modifications

Furnace modifications involved a redesign of the furnace lid to accommodate the placement of two hot samplers, a pyrometer viewport, a camera port, and argon purges to all four of these penetrations. The presence of a camera port on the furnace is not new, however a camera has been mounted on the port for the AGR program for the first time.

Hot samplers were added to enable bed samples to be drawn during a coating run for subsequent analysis. As part of the effort to produce high quality coated particle fuel by more closely following the German coating process than has been done in the past, AGR particles are to be produced in a continuous, uninterrupted coating process.[2] Since particle specifications include the thicknesses and densities of each layer and layer characterization is (at best) difficult following a full-coating run, hot samples of both buffer-coated and IPyC-coated particles are needed. Besides providing for these quality control samples, the hot samplers also enable samples to be taken at any time during the coating processes (when no reactive gases are flowing) to capture the coating properties at various stages.

The pyrometer port was added to enable the bed temperature to be measured optically, when coating gases are not flowing, for comparison to the in-bed and external thermometers. Because the particle emissivities are not well known and change as the coatings are applied, the pyrometer readings will be used more for reference between runs than as definitive temperature measurements.

3.2 Scrubber Modification

During the initial phase of the 6-inch coater tests, when SiC was being deposited, a problem occurred with the off-gas scrubber as a result of significant salt formation in the caustic scrub solution. Sufficient salt was formed to plug the scrubber column. Previously, the liquid effluent from the scrubber was titrated with caustic to neutralize acid and recycled to the scrubber. The increased flow of MTS in this phase of the program resulted in an increased loading of dissolved salt in the scrub solution. The scrubber system was modified to use water, not caustic, and to have a continuous spent scrub blowdown of 45 gph during silicon carbide deposition, thus avoiding the accumulation of salts on the scrubber bed medium.

3.3 Coating Tube and Gas Distributors

The 2-inch inside diameter (ID) coater tube was replaced with a 6-inch ID tube with a threaded end to which a curvilinear bottom could be attached. Two curvilinear bottoms (nicknamed chalices) were designed and fabricated based on parabolic and elliptical profiles. Two conical gas distributors/injectors were designed that are inserted into the bottom of the chalice and held in place with a threaded concentric tube. The concentric tube and the injector formed central and annular flow channels through which the coating gases and fluidizing gases are passed, respectively. The injectors are shaped like a mushroom with a broad, conical cap and a hollow stem. The outer cap margins are fluted to allow inert fluidizing gases to pass through an annular gap between the injector cap and the chalice bottom. The injector cap has a central coating gas inlet orifice and, in one design, five satellite orifices between the central port and the margin flutes. The satellite orifices are angled to impart some vorticity to the bed near the gas injector in an effort to stabilize the gas spout. Short-stemmed versions of the gas injectors have been fabricated to facilitate the addition of a liquid-cooled gas injector line, which should help keep the coating gas cool and minimize the formation of accretions in the gas inlets.

Testing of the uncooled, long-stemmed injectors showed a tendency of long tubular accretions to form on the bi-flow nozzle with a single central coating gas inlet (Figure 1a). These nozzles were not used beyond the initial tests of pyrocarbon deposition because the accretion would have interfered with bed dynamics and may have occluded during silicon carbide deposition. The multi-port injector nozzle, having one central and five satellite orifices performed much better. Accretions remained small through the end of the inner pyrocarbon deposition and a short SiC deposition run (Figure 1b). Use of a liquid-cooled injector may still be warranted.

Figure 1.a Bi-flow injector with accretions

Figure 1.b Multi-port injector with accretions

The inert gas is intended to help move bed from the base of the chalice up the surfaces of the conical injector cap. Computational fluid dynamics (CFD) modeling[4] showed that the inert fluidizing gases would displace gases near the surface of the injector cap to approximately the mid-point where they mixed in with coating gases. The bulk of the inert gas flows against particle movement and climbs the outer wall of the chalice (Figure 2).

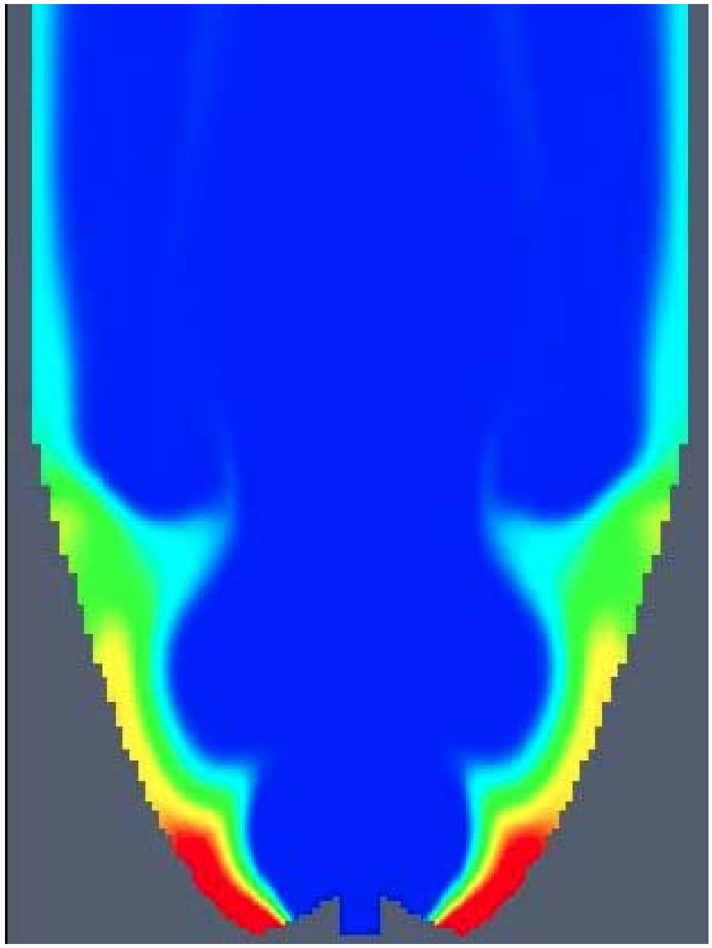

Figure 2. CFD concentration trace of argon gas injected via the annular orifice of a bi-flow injector (red is the highest concentration; blue is the lowest).

4. Control System Upgrade

Initial testing of the upgraded coater was conducted using the antiquated coater control system[3] that had been used during the fuel-development tests with a 2-inch coater. This control system was a GE Fanuc Programmable Logic Controller (PLC) integrated with an operator interface computer and a Centorr furnace controller that had been in service for well over a decade.[3] The system had reliability and maintainability issues because replacement parts have limited availability. Furthermore, gas control and delivery systems were not integrated into a single programmable control system, but relied on operator intervention to establish gas flows and flow control from multiple control panels. A control system upgrade was warranted to promote surety of operations, improve monitoring and delivery of coating and fluidizing gases, and to enable the system to be more readily maintained. In addition to updating the control system, new instrumentation (optical pyrometer, pressure transducer, and differential pressure transmitter) were added to provide additional data input and insight into the operation of the coater with the objective of enhancing coater operation in terms of the quality and reproducibility of particle coatings.

The upgrade integrated all of the control functions into a single operator station and is based on Allen Bradley/Rockwell technologies, which are in wide use throughout industry. Objective evidence for the completion of the furnace and control system upgrades is provided by the results of the control system testing (Appendix A, "Control System Test Results") completed by BWXT and subsequent coating runs (Appendix C, "Documentation of Coater Runs Following Upgrade Modifications"). The pressure transducer system (discussed below), being experimental and not for process control, is not part of the upgraded control system.

5. New Instrumentation

5.1 Optical Pyrometer

The top of the coater furnace enclosure was modified during the upgrade for the 6" coater tube to accommodate an optical pyrometer with a view of the bed media. It is recognized that the pyrometer will not give accurate readings during application of some coatings because the vapor space opacity will conceal the bed and bias the readings, but it should be useful during transition periods when coating gases are not flowing. It is at these times that the optical pyrometer can be compared with in-bed and external thermocouple measurements.

The new pyrometer is an Ircon Mirage fiber optic thermometer with a flexible optical fiber probe that peers through a 1/8" NPT port on the top of the coater flange. The pyrometer is equipped with a digital readout and superfluous proportional-integral-derivative (PID) controller.

5.2 Pressure Instrumentation

One means of monitoring the behavior of a fluidized bed is through observation of the pressure fluctuation signals produced as bubbles form, collapse, and as bed media circulate in the bed. The pressure fluctuations propagate upstream into the gas supply line where they are isolated from the harsh process environment of the coater and can be easily monitored by a high precision pressure transducer. Data from the transducer is filtered through a band pass filter to eliminate aliasing and low frequency signals of little import. The data are processed, using a fast Fourier transform to produce a power spectral density (PSD) of the pressure fluctuations. The PSD serves as a fingerprint for the bed dynamics.

Another pressure tool for observing bed behavior is that of the bed differential pressure, which can provide information regarding the bed mass and whether the bed is fluidized or stagnant. Spouted beds can exhibit a range of differential pressures for a given bed mass depending on gas flow rates, spouting regimes, and the relative quantities of particles that are levitated and those that are not. It is expected that the general trend will be toward increasing bed differential pressure as bed mass and depth increase during the coating process.

The combination of the pressure transducer and differential pressure data provides insight into the bed dynamics. Changes from stable to unstable spouting regimes should manifest themselves by changes in the PSD and possibly in the differential pressure. This information should be helpful in selecting and/or adjusting gas flow rates to attain fluidization patterns that are most conducive to forming particle coatings with the desired properties (isotropy, sphericity, etc.) and with a high degree of uniformity.

The pressure transducers purchased and installed at BWXT were KOBOLD KPK compact high precision pressure transducers with response times of < 1 ms for the electronics (within 10% - 90% of full scale) and up to 150 Hz. One transducer has a 0 – 5 psig range and the other is 0 – 10 psig. The two ranges were purchased because the maximum backpressure on the gas inlet has not been quantified for the 6” coater. Because the backpressures from the bed depth after full TRISO coating and potential accumulation of particulates on the off-gas filters, the pressure transducer having the 0 – 10 psig range was installed and the transducer with the lesser range held in reserve as a spare.

The differential pressure transmitter is an Omega PX771A series transmitter with a 6:1 turndown ratio on the range, which allows it to be sufficiently flexible that a backup instrument is not needed. The signal is filtered with a low-pass filter (nominally at 3 Hz) to reduce “noise” from pressure fluctuations in the fluidized bed so that trends can be more easily discerned. Gradual increases in the differential pressure are the result of increasing bed mass as coatings are deposited and abrupt changes are the result in changes in the spouting behavior of the bed.

Some data from the pressure transducer and differential pressure transmitter are presented in Appendix B, “Sample Pressure Transducer Data” as evidence of the successful installation and testing of the pressure instruments.

6. References

1. SOW-427, “Statement of Work for Industrial Fuel Fabrication and Development”, Rev. 9, dated July 31, 2006.

2. David Petti, Richard Hobbins, James Kendall, and John Saurwein, “Technical Program Plan for the Advanced Gas Reactor Fuel Development and Qualification Program”, INL/EXT-05-00465, Rev. 1, August 2005.

3. Charles Barnes and Douglas Marshall, “Advanced Gas Reactor Coater Scale Up Plan, “PLN-1975, February 1, 2006.

4. C. S. Daw, C. E. A. Finney, and S. Pannala, “Process Modeling Phase II Summary Report for the Advanced Gas Reactor Fuel Development and Qualification Program”, Report for INL MPO 00056009, Rev. 1, Oak Ridge National Laboratory, Jan. 2005

Appendix A – Control System Test Results

03/22/2007 14:00 FAX 434 522 5410 BWXT RTRT 002

BWXT
Nuclear Products Division

To: Clay Richardson

From: Joe Keeley

Date: 3/22/2007

Re: 6 inch Finishing Furnace Electrical Test Plan - Executive Summary

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The electrical test plan for the new control system on the 6 inch finishing furnace was completed on March 16, 2007. The test plan is attached. As a further check of the operability of the control system portions of the annual furnace test were performed to check that the control system operated properly when conditions required for safe operation of the furnace were exceeded. The following conditions were simulated for the annual test:

- Loss of power to coolant pump
- Loss of plant argon supply
- Furnace over temperature
- Low ventilation flow
- Loss of primary coolant flow
- Loss of secondary coolant flow

BWX Technologies, Inc., a McDermott company

Memo Template-Color 10/03 Insert K

March 22, 2007

- Loss of furnace purge gas flow
- Furnace over pressure

In each simulation the furnace successfully performed the required controlled shut down, toxic and flammable gas isolation, and switch to argon fluidization gas. Finally, Bill Pfister has continued to work with us to ensure that the control system meets our needs for the AGR program.

1

ELECTRICAL TEST PLAN
6 INCH FINISHING FURNACE

Test Conducted by: [signature] 3/22/07

Test Witnessed by: Joseph Keeley 3/22/07 / Bruce Tomli 3/22/07

Date: Performed between 3/12 and 3/16

N420: 13750

SECTION 1 – SCREEN NAVIGATION AND ACTION

✓ Verify the application may be started from a single icon on the windows desktop.

On the **Main Menu** screen verify the navigation buttons listed below perform the following actions.

✓	F1 Recipe	display Recipe screen
✓	F2 Flow Gas Test	display Flow Gas Test screen
✓	F3 Evac/Backfill	display Evac/Backfill screen
✓	F4 Info	display Info screen
✓	F5 Start Run	display Start Run screen
✓	F6 Coating Process	display Coating Process screen
✓	F10 Shutdown	display Shutdown popup
✓	F11 Alarms	display Alarm list
✓	F12 Exit	Exit program, return to Windows

On the **Flow Gas Test** screen verify the navigation buttons listed below perform the following actions.

✓	F1 Select Gas	popup gas to select
✓	F2 Start Test	set start bit
✓	F3 Stop Test	set stop bit
✓	F4 Change Flow Rate	popup numeric entry
✓	F5 mA Display	show milliamp display
✓	F6 Change Time	popup time entry
✓	F7 Exhaust Scrubber	set SFSV-1 & SFSV-2 to scrubber
✓	F8 Exhaust Soot Filter	set SFSV-1 & SFSV-2 to soot filter
✓	F12 Last Menu	last screen

✓ The flow gas test works for all gases

✓ The Flow Gas Test screen may be accessed without the evac/backfill being completed.

On the **Recipe Editor** screen verify the navigation buttons listed below perform the following actions.

✓	Open	popup pick list of existing recipes
✓	Save	display Save screen
✓	Preview	popup Recipe Review
✓	Download	download recipe to PLC
✓	Close	last screen

√ Pulldowns for verbs populates appropriate field, actions outlined below

Verb	Variable	Action
Heat cool soak	temperature	start ramp / soak at beginning of step
	gas flows	change at beginning of step
	pop-up	no pop-up
	continue	go to next step when soak time completes
Load	temperature	start ramp / soak at beginning of step
	gas flows	change at beginning of step
	pop-up	pop-up "Load furnace, click CONTINUE when complete" at beginning of step
	continue	go to next step when soak time completes and pop-up has been acknowledged
unload	temperature	start ramp / soak at beginning of step
	gas flow	change at beginning of step
	pop-up	pop-up "Unload furnace, click CONTINUE when complete" at beginning of step
	continue	go to next step when soak time completes and pop-up has been acknowledged
Coat	temperature	start ramp at beginning of step – soak time will be used as coat time
	gas flow - fluidization	change at beginning of step
	gas flow - reactant	start after pop-up is acknowledged, start coat timer stop flow when coat timer completes
	pop-up	pop-up "Ready to flow reactant gases? - click CONTINUE when ready – <KEY> to edit recipe" at beginning of step. (operator may begin coat, edit recipe, or shutdown)
	continue	go to next step when coat timer completes
flow MTS	temperature	start ramp at beginning of step – soak time will be used as coat time
	gas flow - fluidization	change at beginning of step
	gas flow - reactant	start after pop-up is acknowledged, start coat timer stop flow when coat timer completes
	pop-up	pop-up "Ready to flow MTS? - click CONTINUE when ready – <KEY> to edit recipe" at beginning of step. (operator may begin coat, edit recipe, or shutdown) Additionally, display status of exhaust valves and function key to switch to scrubber. Permit flow only if both exhaust valve's limit switches indicate "to scrubber"
	continue	go to next step when coat timer completes
sample	temperature	start ramp / soak at beginning of step
	gas flow	change at beginning of step
	pop-up	pop-up "Draw sample, click CONTINUE when complete" at beginning of step
	continue	go to next step when soak time completes and pop-up has been acknowledged
switch gas	temperature	start ramp / soak at beginning of step
	gas flow	change from 100% of last step flow to 100% of this step flow in 30 seconds at beginning of step
	pop-up	None
	continue	go to next step when soak time completes
Start ext data	temperature	start ramp / soak at beginning of step
	gas flows	change at beginning of step
	pop-up	no pop-up – enables output to external data acquisition system
	continue	go to next step when soak time completes

stop ext data	temperature	start ramp / soak at beginning of step
	gas flows	change at beginning of step
	pop-up	no pop-up -- disables output to external data acquisition system
	continue	go to next step when soak time completes

✓ Pulldowns for Gas Selection — populates appropriate field

✓ (argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene)

On the **Evac/Backfill** screen verify the navigation buttons listed below perform the following actions.

✓	F1 Start	Begins the automatic sequence of evacuating and inert back filling three times to a certain pressure. The display should indicate the current number of cycles.
✓	F3 Abort	Stops automatic sequence.
✓	F4 Info	display Info screen
✓	F5 Open Exhaust	Opens exhaust valves FCV90 and FCV91
✓	F6 Close Exhaust	Closes exhaust valves FCV90 and FCV91
✓	F7 Exhaust to Scrubber	Closes valve SFSV-1 and 2 to scrubber position
✓	F8 Exhaust to Soot Filter	Opens valve SFSV-1 and 2 to soot position
✓	F10 Shutdown	display Shutdown popup
✓	F11 Alarms	display Alarm list
✓	F12 Last Menu	displays last menu

✓ The Evac/Backfill must be completed prior to heating the furnace.

On the **Start Run** screen verify the navigation buttons listed below perform the following actions.

✓	F1 Recipe	display Recipe screen
✓	F2 Enter Run Name	popup prompt for run name
✓	F3 Review Recipe	popup review recipe window
✓	F4 Accept Recipe	popup to check off recipe
✓	F5 Flow Gas Test	display Flow Gas Test
✓	F6 Evac/Backfill	display Evac/Backfill screen
✓	F7 Run Coat Process	display Run Coat Process screen
✓	F10 Shutdown	display Shutdown popup
✓	F11 Alarms	displays Alarm list
✓	F12 Main Menu	display Main menu screen

On the **Coat** screen verify the navigation buttons listed below perform the following actions.

✓	F1 Run	begins recipe run
✓	F2 Hold	holds current temperature and gas flow and does not increment hold timer
✓	F4 Info	displays information screen
✓	F5 Modify Recipe	displays recipe editor screen
✓	F10 Shutdown	display Shutdown popup
✓	F11 Alarms	display Alarm list
✓	F12 Last Menu	display last menu

√ The display includes TC7, TC10, pyrometer, setpoint temp, time at hold temp, gas flows, temperature setpoint, and ramp rate readings.

On the **Info** screen verify the navigation buttons listed below perform the following actions.

√	F1 Gas Supply	display Gas Supply screen
√	F2 Cooling	display Furnace Cool screen
√	F3 Temp Trend	display Temp Trend screen
√	F4 Flow Trend	display Flow Trend screen
√	F5 Open Exhaust	Opens exhaust valves FCV90 and FCV91
√	F6 Close Exhaust	Closes exhaust valves FCV90 and FCV91
√	F7 Exhaust to Scrubber	Closes valve SFSV-1 and 2 to scrubber position
√	F8 Exhaust to Soot Filter	Opens valve SFSV-1 and 2 to soot position
√	F10 Shutdown	display Shutdown popup
√	F11 Alarms	display Alarm list
√	F12 Last Menu	last screen

On the **Gas Supply** screen verify the navigation buttons listed below perform the following actions.

√	F10 Shutdown	display Shutdown popup
√	F11 Alarms	display Alarm list
√	F12 Last Menu	last screen

√ The gas flows are displayed (plant and bottle argon), the pressure switch and valve states are displayed.

On the **Furnace Cool** screen verify the navigation buttons listed below perform the following actions.

√	F10 Shutdown	display Shutdown popup
√	F11 Alarms	display Alarm list
√	F12 Last Menu	last screen

√ The display shows the 15 flow switches, 2 pumps 4 RTD pairs, pump isolation, cooling water supply

On the **Temp Trend** screen verify the navigation buttons listed below perform the following actions.

√	F10 Shutdown	display Shutdown popup
√	F11 Alarms	display Alarm list
√	F12 Last Menu	last screen

√ The following temperatures are displayed.
Six type C thermocouples (including TC3 and TC10)
Optical pyrometer(s)

On the **Flow Trend** screen verify the navigation buttons listed below perform the following actions.

√	F10 Shutdown	display Shutdown popup
√	F11 Alarms	display Alarm list
√	F12 Last Menu	last screen

√ The gas flows are displayed: argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene

On the **Display Inputs** screen verify the navigation buttons listed below perform the following actions.

✓ The mA reading for the analog inputs are displayed.

On the **Display Outputs** screen verify the navigation buttons listed below perform the following actions.

✓ The mA readings for the analog outputs are displayed.

SECTION 2 – RECIPE MANAGEMENT / GAS FLOW / TEMPERATURE PROFILE

Verify the following recipe management attributes.

✓ Enter 20 recipes and save.

✓ Enter a maximum of 50 recipe steps in one recipe and save.

✓ Each recipe has its own unique display

✓ Change all setpoints during a run – temperature, ramp rate, time, hold temperature, and gas flows. Include changing a current step and a future step.

Verify the following gas flow attributes.

✓ Gas flows are controlled by recipe setpoints

✓ The switch gas routine is utilized when activated by recipe and performs accordingly.

✓ Gas flow settings and actual flow are displayed on the operator screen.

✓ There is a mA display for the flow meters (diagnostics).

✓ Eight gases may flow at one step.

Verify the following temperature profile attributes.

✓ Furnace temperature may be controlled to 2200 degrees Celsius

✓ Furnace temperature is controlled by recipe setpoints.

✓ Temperature settings and actual temperature are displayed on the operator screen.

✓ Heat up step begins a ramp.

✓ Cool down step stops heat and cools to setpoint.

✓ Hold halts the coating timer and maintains the current step.

✓ Recipe 1 (see attachment) ran successfully.

✓ Recipe 2 (see attachment) ran successfully.

✓ Recipe 3 (see attachment) ran successfully.

SECTION 3 – DATA ACQUISITION

✓ The changed setpoints are saved as final data

✓ The following data are saved.

- ✓ All temperatures from monitoring, control, and overtemperature thermocouples
- ✓ gas pressures (argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene) (no pressures for acetylene / propylene)
- ✓ gas flows(argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene, H2 sweep and bypass from MTS cabinet, MTS flow, MTS vaporizer and tank weight)
- ✓ Final recipe setpoints

SECTION 4 – WARNINGS

Verify the following warning give a visual warning only. The warning screen will be accessed through a function key. When the condition is corrected the visual indicator and screen will stop

✓ The mA reading for the analog inputs are displayed.

On the **Display Outputs** screen verify the navigation buttons listed below perform the following actions.

✓ The mA readings for the analog outputs are displayed.

SECTION 2 – RECIPE MANAGEMENT / GAS FLOW / TEMPERATURE PROFILE

Verify the following recipe management attributes.

✓ Enter 20 recipes and save.
✓ Enter a maximum of 50 recipe steps in one recipe and save.
✓ Each recipe has its own unique display
✓ Change all setpoints during a run – temperature, ramp rate, time, hold temperature, and gas flows. Include changing a current step and a future step.

Verify the following gas flow attributes.

✓ Gas flows are controlled by recipe setpoints
✓ The switch gas routine is utilized when activated by recipe and performs accordingly.
✓ Gas flow settings and actual flow are displayed on the operator screen.
✓ There is a mA display for the flow meters (diagnostics).
✓ Eight gases may flow at one step.

Verify the following temperature profile attributes.

✓ Furnace temperature may be controlled to 2200 degrees Celsius
✓ Furnace temperature is controlled by recipe setpoints.
✓ Temperature settings and actual temperature are displayed on the operator screen.
✓ Heat up step begins a ramp.
✓ Cool down step stops heat and cools to setpoint.
✓ Hold halts the coating timer and maintains the current step.

✓ Recipe 1 (see attachment) ran successfully.
✓ Recipe 2 (see attachment) ran successfully.
✓ Recipe 3 (see attachment) ran successfully.

SECTION 3 – DATA ACQUISITION

✓ The changed setpoints are saved as final data
✓ The following data are saved.
  ✓ All temperatures from monitoring, control, and overtemperature thermocouples
  ✓ gas pressures (argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene) (no pressures for acetylene / propylene)
  ✓ gas flows(argon, auxiliary argon, hydrogen, auxiliary hydrogen, hydrogen, acetylene, propylene, H2 sweep and bypass from MTS cabinet, MTS flow, MTS vaporizer and tank weight)
  ✓ Final recipe setpoints

SECTION 4 – WARNINGS

Verify the following warning give a visual warning only. The warning screen will be accessed through a function key. When the condition is corrected the visual indicator and screen will stop

√ Control thermocouple failure
√ Overtemperature controller alarm

√ The alarms may be acknowledged.
√ All alarms activate the horn.
√ The horn may be silenced.
√ The furnace run may be restarted if the alarm is recovered quickly.

SECTION 6 – HARDWARE

Verify the following hardware attributes.
√ System has spare inputs for 10 future gases
√ System has spare outputs for 10 future gases
√ The emergency stop trips the main breaker and all power is disabled. Fail open valves allow fluidization argon to flow to the furnace.
√ The independent overtemperature controller disables the heat contactors.
| √ The cycle stop push button stops heat and reactant gas flows and flows fluidization argon.

SECTION 7 – NETWORK

√ Verify the recipe continues to run uninterrupted when the network cable is unplugged.

Appendix B – Sample Pressure Transducer Data

On March 20th, pressure response data were collected for a 750 gram charge of nominally 400-µm zirconia beads in the coater tube. Two matrices of gas flows to the main distributor and the annulus at gas temperatures near coating temperatures were used for argon (1312ºC - 1383ºC) and for hydrogen (1426ºC - 1518ºC) fluidization. Changes were noted in the amplitude of the pressure fluctuations and the mean frequency as flow rates were changed. The power spectral density, however, remained monomodal. This may have been due to the relatively shallow bed; matching bed charge used for coating trials, but less than the depth achieved by the end of coating. A screenshot of the human-machine interface for the pressure instrumentation and an example of the changing PSD as annular gas flow rate is changed are shown in Figures B-1 and B-2, respectively.

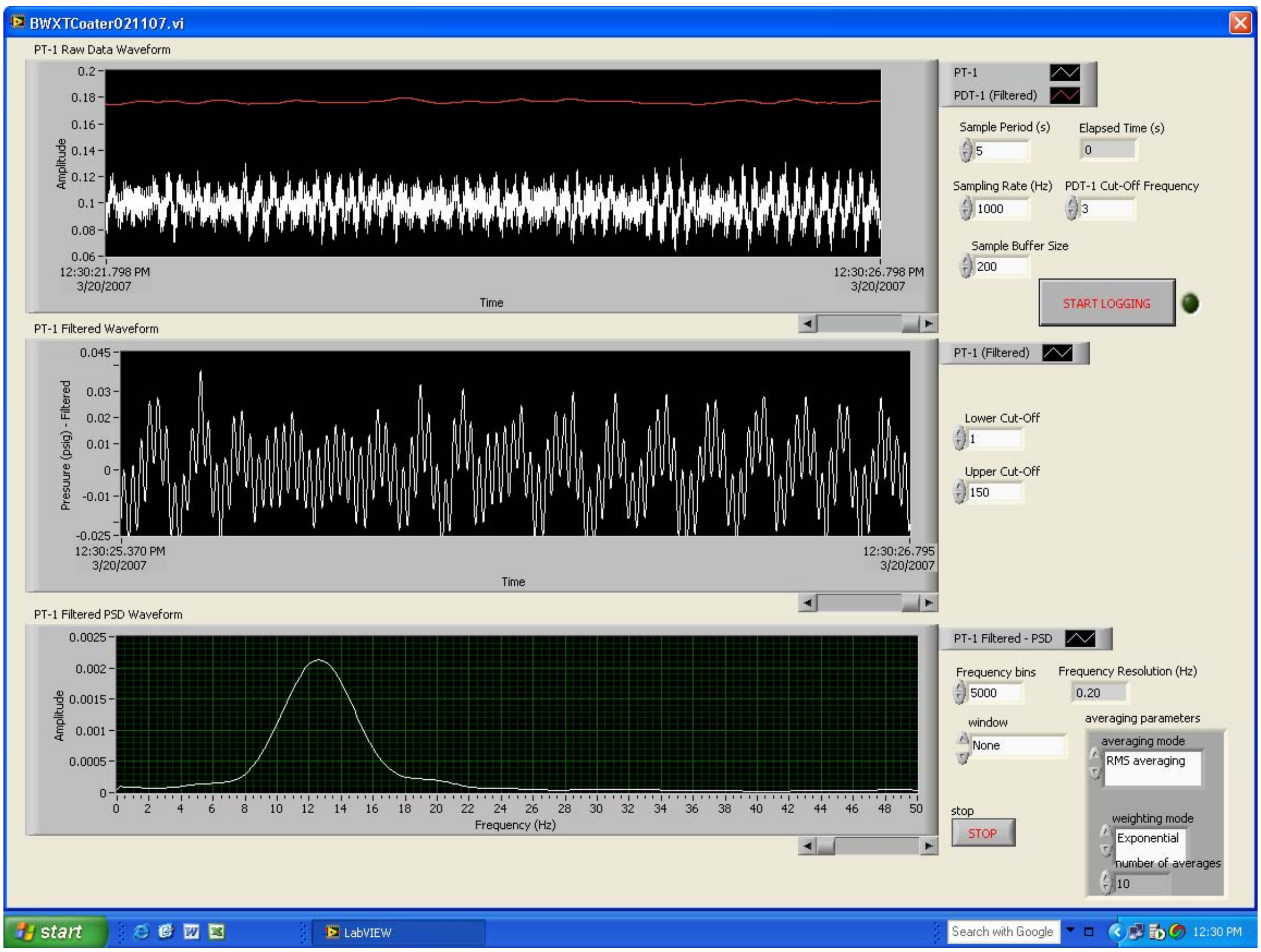


Figure B-1. Screenshot of pressure transducer and differential pressure transmitter data.

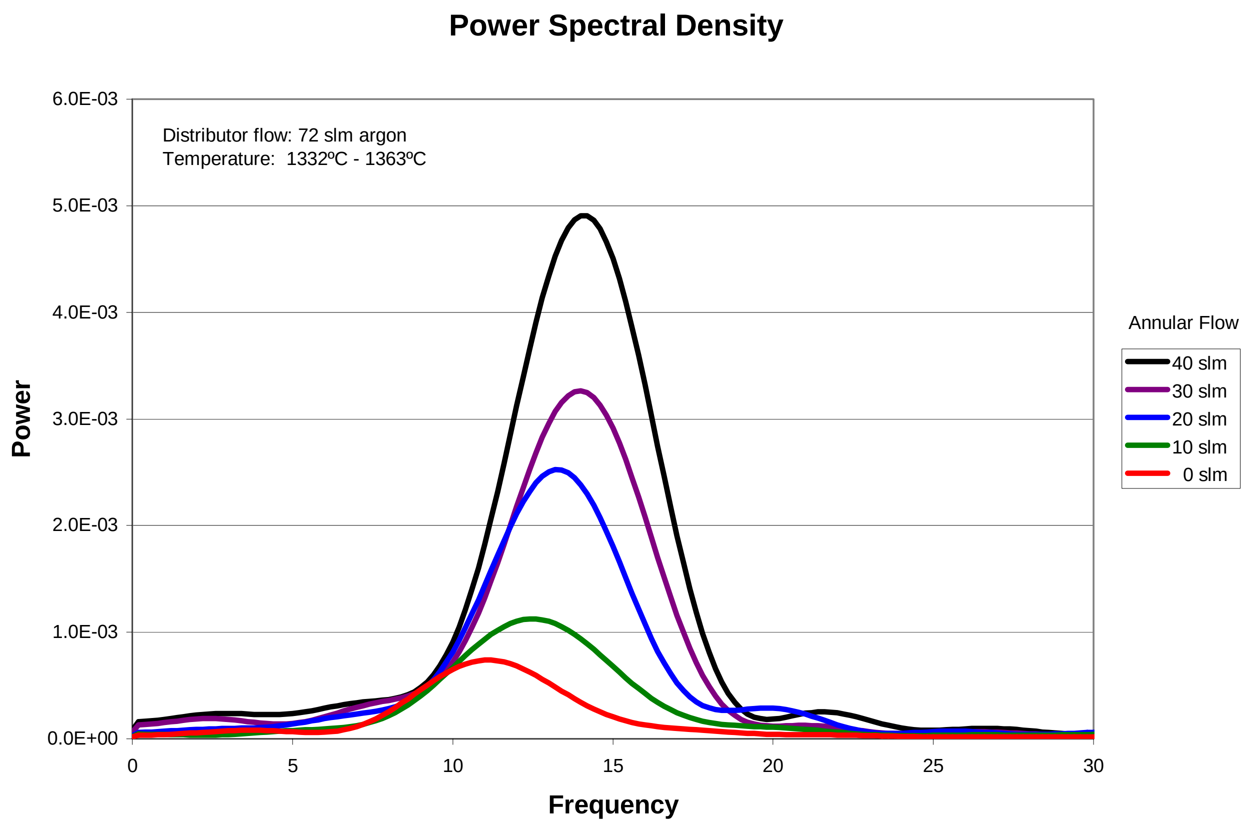


Figure B-2. Graph of the pressure transducer PSD at a constant distributor Ar gas flow and variable annular Ar gas flow.

The screenshot in Figure B-1 shows three graph windows. The top window shows a plot of the differential pressure transmitter data filtered to eliminate fluctuation "noise" over 3 Hz. This is seen as a relatively smooth line in the window. Raw (unfiltered) data from the pressure transducer is also shown in the top window. The second window displays the pressure transducer data after being conditioned by a band-pass filter to remove high frequency noise, aliasing, and low frequency variations that are not related to bed movement. The bottom window is a plot of the power spectral density of the filtered pressure transducer data.

Figure B-2 shows the changes in the PSD when fluidizing the 750 grams of 400 µm zirconia kernels with argon. Gas flow to the coating gas distributor was held constant at 72 slpm while the flow to the annulus was varied from 0 – 40 slpm. The character of the PSD remained monomodal with the change in gas flows, for the shallow bed, but a shift in the rise in the power and a shift in the characteristic frequency are evident.

Figure B-3 shows the PSD for a 750 gm charge of 400-µm zirconia kernels and the PSDs for the bed during coating conditions within 1 minute of termination of each of the successive coatings. Particles coated with a buffer and with a buffer and IPyC layer exhibited a bimodal distribution while the others were largely monomodal. The bed and coating conditions that produced the PSDs are given in Table B-1. After the coating run was initiated, it was discovered that full argon flow could not be achieved to the annulus. This resulted in less annular flow than would be normally had during IPyC and OPyC coatings and somewhat diminished flow during the buffer coating.

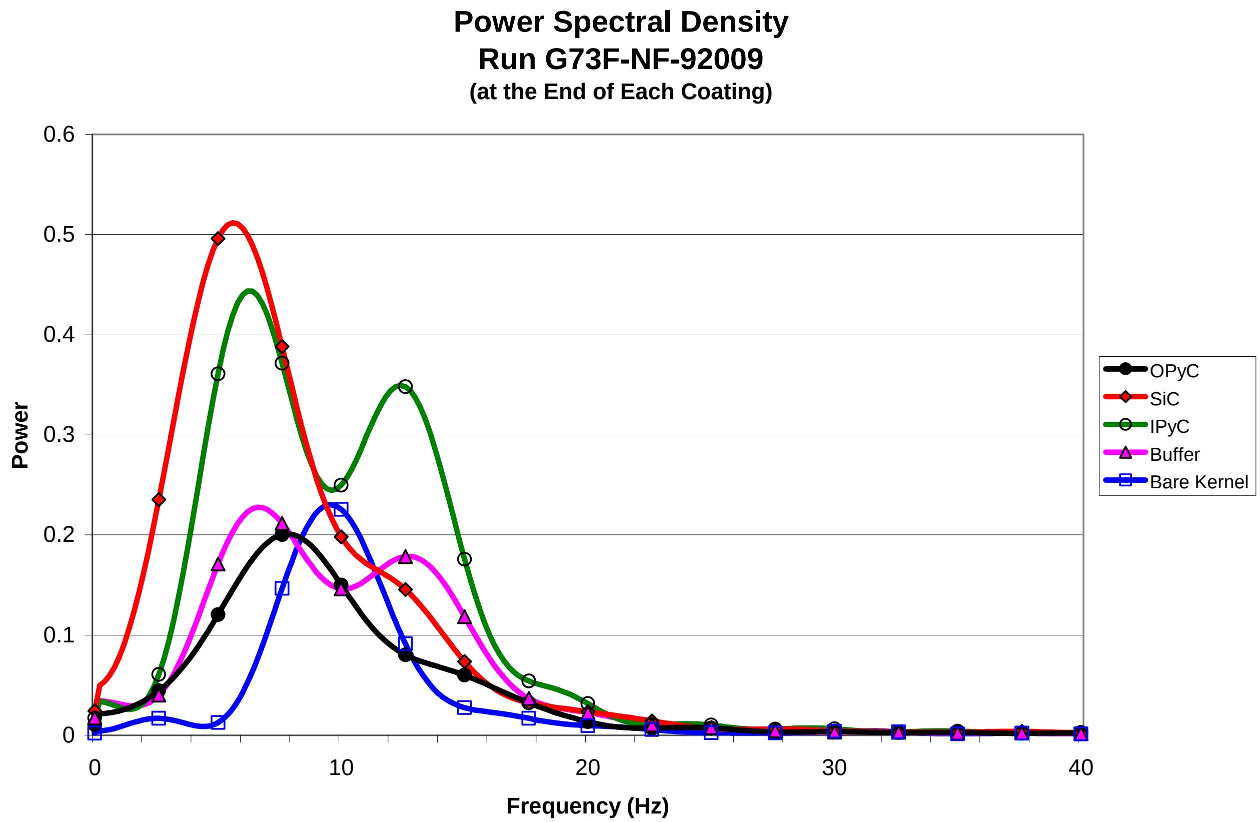


Figure B-3. Comparison of bed PSD toward the end of each successive coating.

Table B-1. Coating parameters for coating run G73F-NF-92009

Coating	Temperature	Bed Mass	Particle Properties		Distributor Gases	*Annulus Gas
			Density	Diameter		
Kernel	1379°C	0.75 kg	6.0 gm/cc	400 µm	37 slpm Ar	4 slpm Ar
Buffer	~1460°C	~1.0 kg	~2.5 gm/cc	~590 µm	37 slpm Ar 61.4 slpm C_2H_2	2 - 4 slpm Ar
IPyC	1215°C	~1.4 kg	~2.3 gm/cc	~675 µm	109 slpm Ar 27.5 slpm C_2H_2 23.5 slpm C_3H_6	~2.3 slpm Ar
SiC	1510°C	~2.1 kg	~2.5 gm/cc	~750 µm	178 slpm H_2 1.2 kg MTS/hr	18.3 slpm H_2
OPyC	1225°C	~2.6 kg	~2.4 gm/cc	~800 µm	98 slpm Ar 24 slpm C_2H_2 21 slpm C_3H_6	~4 slpm Ar
* Annulus was apparently restricted by embedded kernels from the "flow ladder" testing, conducted the day before the coating run, and could not deliver the full flow of argon (11 slpm).						

Appendix C – Documentation of Coater Runs Following Upgrade Modifications

Index

Run Sheets and Particle Images from Run 92008, Performed March 17, 2007

Run Sheets and Particle Images from Run 92009, Performed March 21, 2007

UNCLASSIFIED

3/19/2007
6:04 AM

Run ID Buffer Substrate Input	Acetylene	Run ID IPyC Substrate Input	Propylene	Run ID SiC Substrate Input	MTS	Run ID OPyC Substrate Input	Propylene
Substrate ID	Zirbeads	Substrate ID	Zirbeads	Substrate ID	Zirbeads	Substrate ID	Zirbeads
Substrate Weight (g)	750	Substrate Weight (g)	1046.9	Substrate Weight (g)	1412.2	Substrate Weight (g)	2083.7
Substrate Diameter (μ)	400						
Substrate Diameter (cm)	0.04	Substrate Diameter (cm)	0.06	Substrate Diameter (cm)	0.068	Substrate Diameter (cm)	0.075
Substrate Density (abs - g/cc)	6.00	Substrate Density (abs - g/cc)	2.52	Substrate Density (abs - g/cc)	2.32	Substrate Density (abs - g/cc)	2.54
Est. Volume (cc)	208.33	Est. Volume (cc)	692.38	Est. Volume (cc)	1014.48	Est. Volume (cc)	1367.24

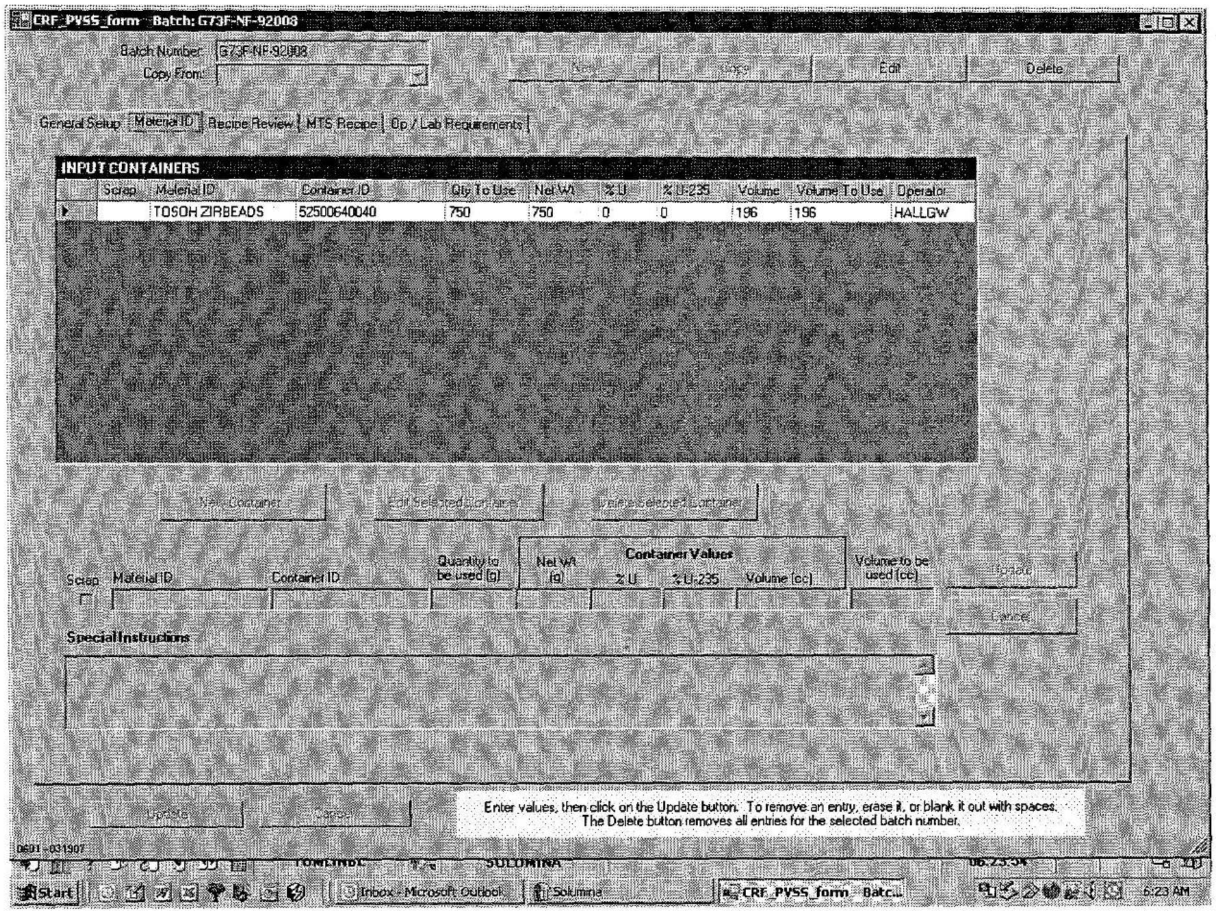
Coating Data		Coating Data		Coating Data		Coating Data	
TOTAL Thickness (cm)	0.01	TOTAL Thickness (cm)	0.004	TOTAL Thickness (cm)	0.0035	TOTAL Thickness (cm)	0.004
Substrate plus buffer thickness (cm)	0.06	Substrate plus IPyC thickness (cm)	0.068	Substrate plus SiC thickness (cm)	0.075	Substrate plus OpyC thickness (cm)	0.083
Carbon Density	1.0	Carbon Density	1.9	Silicon Carbide Density (g/cc)	3.20	Carbon Density	1.9
		Prop Flow	46%	MTS Density (g/cc)	1.273	Prop Flow	46%
Wt. Carbon Needed (g)	296.89	Wt. Carbon Needed (g)	365.3	Wt. SiC Needed (g)	671.5	Wt. Carbon Needed (g)	556.3
Assumed Bed Eff. (%)	62.0%	Assumed Bed Eff. (%)	42.0%	Assumed Bed Eff. (%)	90.0%	Assumed Bed Eff. (%)	42.0%
Carbon To Use (g)	478.8	Carbon To Use (g)	869.7	MTS To Use (g)	2509.8	Carbon To Use (g)	1324.6
Acetylene Needed (g)	518.73	Acet/Prop Needed (g)	982.83	MTS Needed (g)	2788.67	Acet/Prop Needed (g)	1496.86
		Acet Flow	54.0%	Vol MTS Needed (cc) liquid	2190.83	Acet Flow	54.0%
Acetylene Needed (l)	467.3	Acet/Prop Needed (l)	767.7	MTS Needed (l) liquid	2.191	Acet/Prop Needed (l)	1169.2

Run Setup Parameters		Run Setup Parameters		Run Setup Parameters		Run Setup Parameters	
Initial Coating Rate (microns/min)	13.2	Initial Coating Rate (microns/min)	2.7	Initial Coating Rate (microns/min)	0.25	Initial Coating Rate (microns/min)	1.6
Initial Coating Thickness (μm)	100	Initial Coating Thickness (μm)	40	Initial Coating Thickness (μm)	35	Initial Coating Thickness (μm)	40
Initial Coating Time (minutes)	7.58	Initial Coating Time (minutes)	14.81	Initial Coating Time (minutes)	140.00	Initial Coating Time (minutes)	25.00
Acetylene for Initial Coat (l)	467.3	Acet/Prop for Initial Coat (l)	767.7	MTS for Initial Coat (g)	2788.67	Acet/Prop for Initial Coat (l)	1169.2
Initial C2H2 Flowrate (lpm)	61.69	Initial C2H2 Flow (lpm)	27.96	Initial MTS Flowrate (g/hr)	1195.14	Initial C2H2 Flow (lpm)	25.26
		Initial C3H6 Flowrate (lpm)	23.84			Initial C3H6 Flowrate (lpm)	21.81
Total Gas Flow (lpm)	102.81	Total Gas Flow (lpm)	172.74	Moles MTS Needed	18.65	Total Gas Flow (lpm)	155.90
Minimum Argon Flow (lpm)	41.12	Minimum Argon Flow (lpm)	120.92	Volume MTS Gas Needed (l)	417.83	Minimum Argon Flow (lpm)	109.13
Argon Flow - Annular (lpm)	4.11	Argon Flow - Annular (lpm)	12.09	MTS Gas Flow Rate (lpm)	2.98	Argon Flow - Annular (lpm)	10.91
Argon Flow - Fluidization (lpm)	37.01	Argon Flow - Fluidization (lpm)	108.82	Total Gas Flow (lpm)	198.97	Argon Flow - Fluidization (lpm)	98.22
				Minimum Hydrogen Flow (lpm)	195.98		
				MTS Sweep Flow (lpm)	23.88		
				Annular Flow (lpm)	19.60		
				Hydrogen Flow (lpm)	152.61		

x=propylene
y=acetylene
$x/y = 0.85 \quad x=.85y$
$x + y = 1.0$
$.85y + y = 1$
$y = 1/1.85$
$y = 0.54$
$x = 1 - 0.54 = 0.46$

UNCLASSIFIED

G73F-NF-92008.xls
Coating Calc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Batch Number: G73F-NF-92008
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Edit
Delete
General Setup
Material ID
Recipe Review
MTS Recipe
Op / Lab Requirements
INPUT CONTAINERS
Scrap
Material ID
Container ID
Qty To Use
Net Wt
% U
% U-235
Volume
Volume To Use
Operator
TOSOH ZIRBEADS
52500640040
750
750
0
0
196
196
HALLGW
Container Values
Quantity to be used (g)
Net Wt (g)
Volume (cc)
Volume to be used (cc)
Special Instructions
Enter values, then click on the Update button. To remove an entry, erase it, or blank it out with spaces.
The Delete button removes all entries for the selected batch number.
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Solumina
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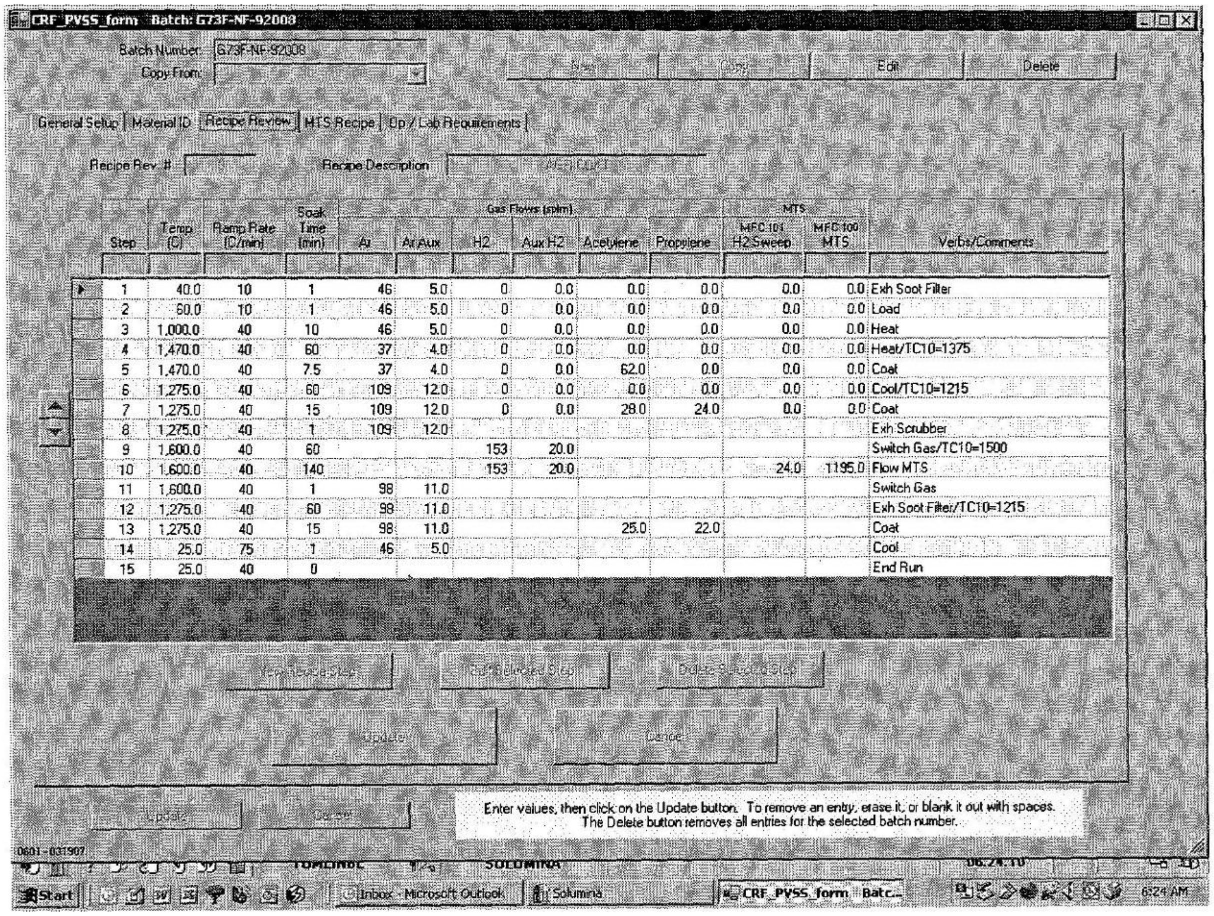

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Batch Number: G73F-NF-92008

Copy From:

New | Copy | Edit | Delete

General Setup | Material ID | Recipe Review | MTS Recipe | Op / Lab Requirements

Recipe Rev. #

Recipe Description

Step	Temp (C)	Ramp Rate (C/min)	Soak Time (min)	Gas Flows (slpm) Ar	Ar Aux	H2	Aux H2	Acetylene	Propylene	MTS MFC 101 H2 Sweep	MFC 100 MTS	Verbs/Comments
1	40.0	10	1	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Exh Soot Filter
2	60.0	10	1	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Load
3	1,000.0	40	10	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Heat
4	1,470.0	40	60	37	4.0	0	0.0	0.0	0.0	0.0	0.0	Heat/TC10=1375
5	1,470.0	40	7.5	37	4.0	0	0.0	62.0	0.0	0.0	0.0	Coat
6	1,275.0	40	60	109	12.0	0	0.0	0.0	0.0	0.0	0.0	Cool/TC10=1215
7	1,275.0	40	15	109	12.0	0	0.0	28.0	24.0	0.0	0.0	Coat
8	1,275.0	40	1	109	12.0							Exh Scrubber
9	1,600.0	40	60			153	20.0					Switch Gas/TC10=1500
10	1,600.0	40	140			153	20.0			24.0	1195.0	Flow MTS
11	1,600.0	40	1	98	11.0							Switch Gas
12	1,275.0	40	60	98	11.0							Exh Soot Filter/TC10=1215
13	1,275.0	40	15	98	11.0			25.0	22.0			Coat
14	25.0	75	1	46	5.0							Cool
15	25.0	40	0									End Run

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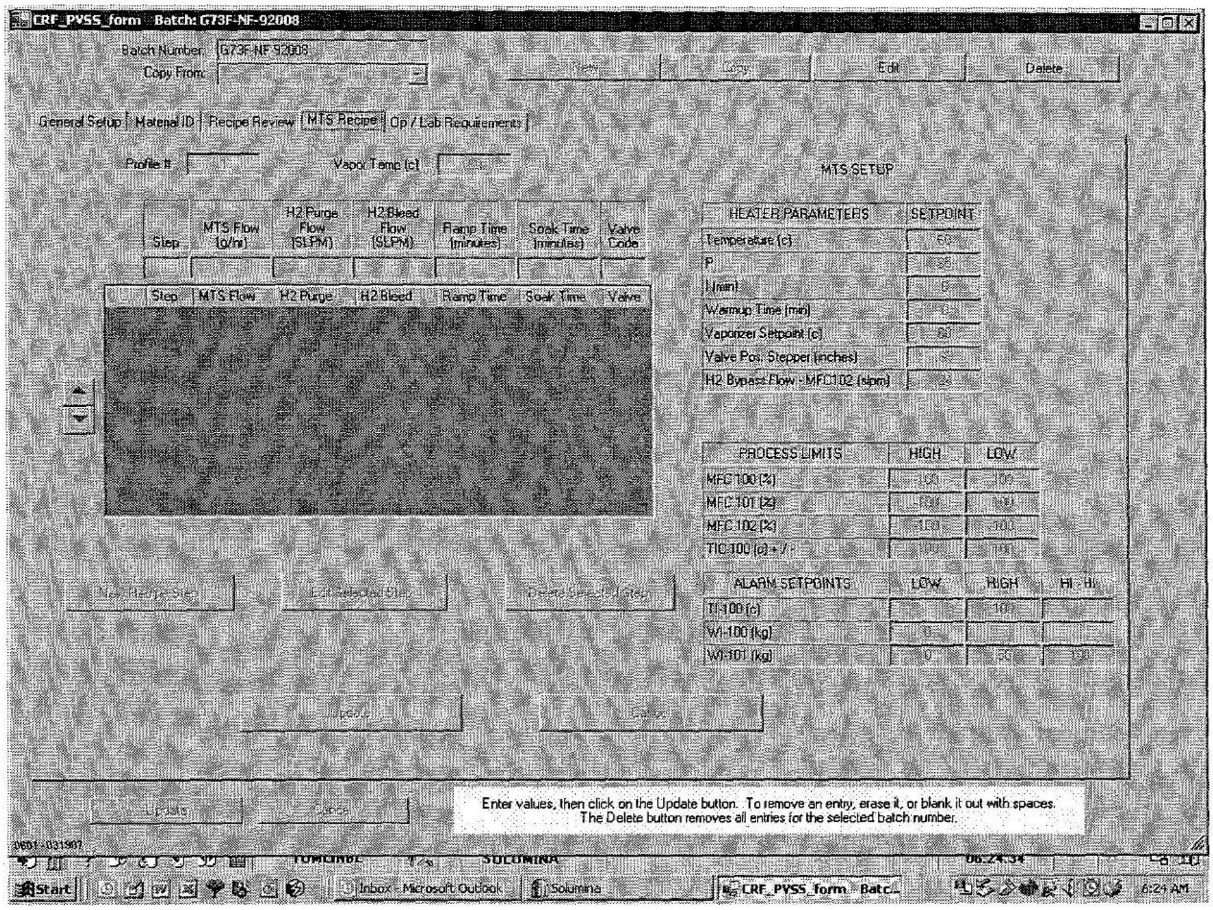
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Material ID
Recipe Review
MTS Recipe
Op / Lab Requirements
Profile #
Vapor Temp (c)
MTS SETUP
Step
MTS Flow (g/hr)
H2 Purge Flow (SLPM)
H2 Bleed Flow (SLPM)
Ramp Time (minutes)
Soak Time (minutes)
Valve Code
HEATER PARAMETERS
SETPOINT
Temperature (c)
P
I (min)
Warmup Time (min)
Vaporizer Setpoint (c)
Valve Pos. Stepper (inches)
H2 Bypass Flow - MFC102 (slpm)
PROCESS LIMITS
HIGH
LOW
MFC 100 (%)
MFC 101 (%)
MFC 102 (%)
TIC 100 (c) + / -
ALARM SETPOINTS
TI-100 (c)
WI-100 (kg)
WI-101 (kg)
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The Delete button removes all entries for the selected batch number.
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Inbox - Microsoft Outlook
Solumina
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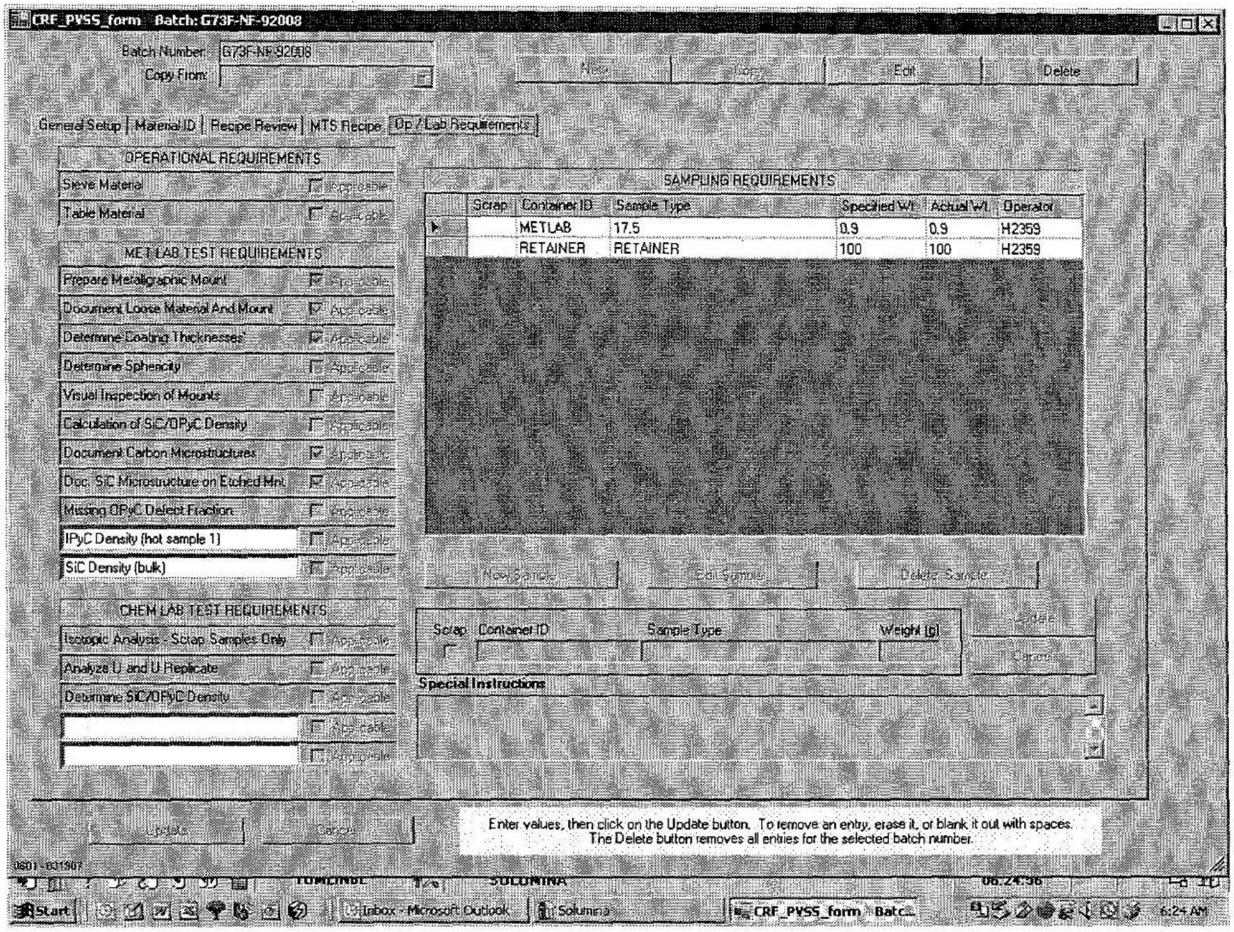
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Batch Number: G73F-NF-92008
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General Setup | Material ID | Recipe Review | MTS Recipe | Op / Lab Requirements
OPERATIONAL REQUIREMENTS
Sieve Material
Table Material
MET LAB TEST REQUIREMENTS
Prepare Metallographic Mount
Document Loose Material And Mount
Determine Coating Thicknesses
Determine Sphericity
Visual Inspection of Mounts
Calculation of SiC/OPyC Density
Document Carbon Microstructures
Doc. SiC Microstructure on Etched Mnt.
Missing OPyC Defect Fraction
IPyC Density (hot sample 1)
SiC Density (bulk)
CHEM LAB TEST REQUIREMENTS
Isotopic Analysis - Scrap Samples Only
Analyze U and U Replicate
Determine SiC/OPyC Density
SAMPLING REQUIREMENTS
Scrap Container ID Sample Type Specified Wt. Actual Wt. Operator
METLAB 17.5 0.9 0.9 H2359
RETAINER RETAINER 100 100 H2359
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Edit Sample
Delete Sample
Scrap Container ID Sample Type Weight (g)
Update
Cancel
Special Instructions
Enter values, then click on the Update button. To remove an entry, erase it, or blank it out with spaces.
The Delete button removes all entries for the selected batch number.
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Inbox - Microsoft Outlook
Solumina
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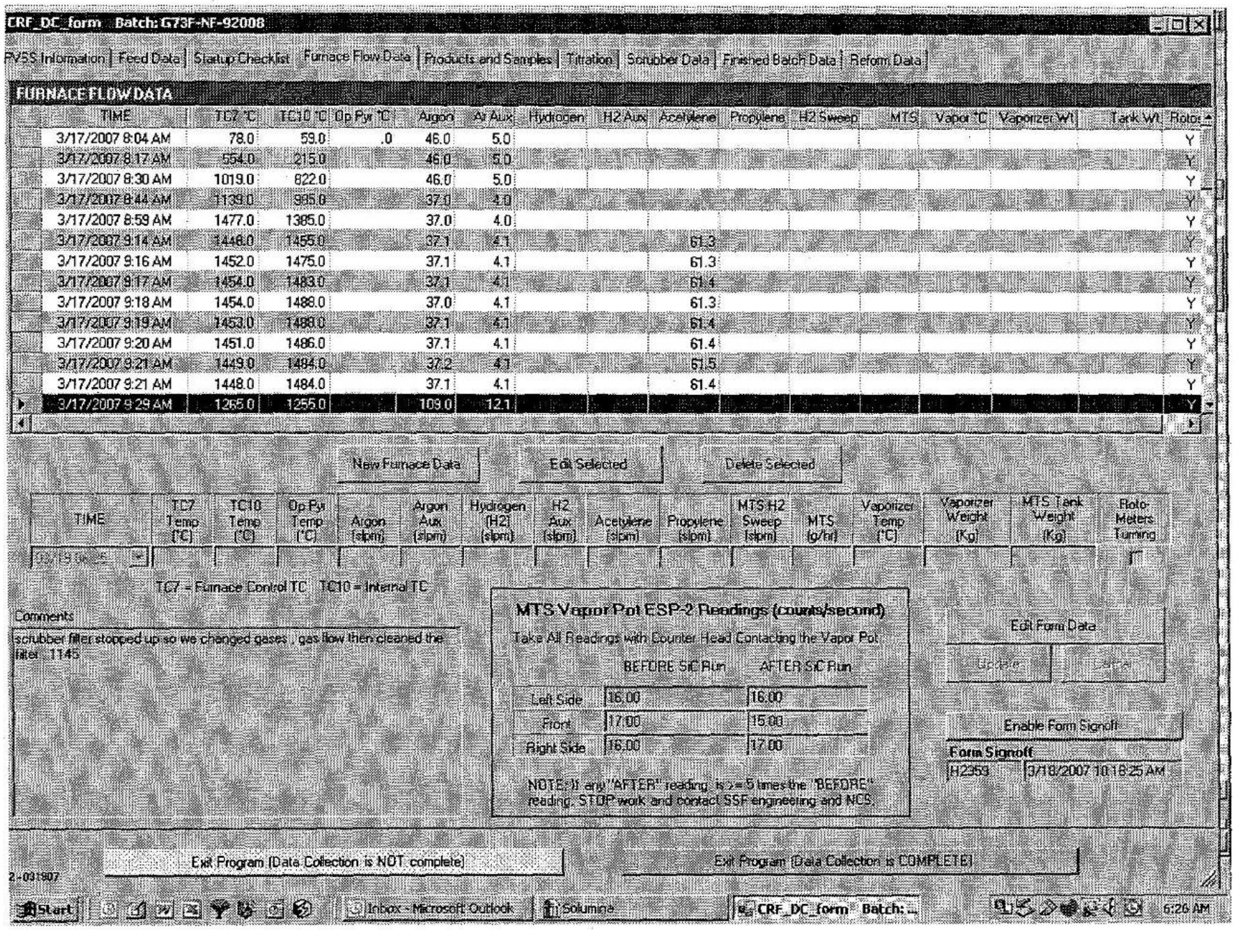
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FURNACE FLOW DATA
TIME | TC7 °C | TC10 °C | Op Pyr °C | Argon | Ar Aux | Hydrogen | H2 Aux | Acetylene | Propylene | H2 Sweep | MTS | Vapor °C | Vaporizer Wt | Tank Wt | Roto
3/17/2007 8:04 AM 78.0 59.0 .0 46.0 5.0 Y
3/17/2007 8:17 AM 554.0 215.0 46.0 5.0 Y
3/17/2007 8:30 AM 1019.0 822.0 46.0 5.0 Y
3/17/2007 8:44 AM 1139.0 995.0 37.0 4.0 Y
3/17/2007 8:59 AM 1477.0 1385.0 37.0 4.0 Y
3/17/2007 9:14 AM 1448.0 1455.0 37.1 4.1 61.3 Y
3/17/2007 9:16 AM 1452.0 1475.0 37.1 4.1 61.3 Y
3/17/2007 9:17 AM 1454.0 1483.0 37.1 4.1 61.4 Y
3/17/2007 9:18 AM 1454.0 1488.0 37.0 4.1 61.3 Y
3/17/2007 9:19 AM 1453.0 1488.0 37.1 4.1 61.4 Y
3/17/2007 9:20 AM 1451.0 1486.0 37.1 4.1 61.4 Y
3/17/2007 9:21 AM 1449.0 1494.0 37.2 4.1 61.5 Y
3/17/2007 9:21 AM 1448.0 1484.0 37.1 4.1 61.4 Y
3/17/2007 9:29 AM 1265.0 1255.0 109.0 12.1 Y
New Furnace Data
Edit Selected
Delete Selected
TIME | TC7 Temp (°C) | TC10 Temp (°C) | Op Pyr Temp (°C) | Argon (slpm) | Argon Aux (slpm) | Hydrogen (H2) (slpm) | H2 Aux (slpm) | Acetylene (slpm) | Propylene (slpm) | MTS H2 Sweep (slpm) | MTS (g/hr) | Vaporizer Temp (°C) | Vaporizer Weight (Kg) | MTS Tank Weight (Kg) | Roto-Meters Turning
TC7 = Furnace Control TC TC10 = Internal TC
Comments
scrubber filter stopped up so we changed gases, gas flow then cleaned the filter 1145
MTS Vapor Pot ESP-2 Readings (counts/second)
Take All Readings with Counter Head Contacting the Vapor Pot
BEFORE SiC Run AFTER SiC Run
Left Side 16.00 16.00
Front 17.00 15.00
Right Side 16.00 17.00
NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.
Edit Form Data
Enable Form Signoff
Form Signoff
H2359 3/18/2007 10:18:25 AM
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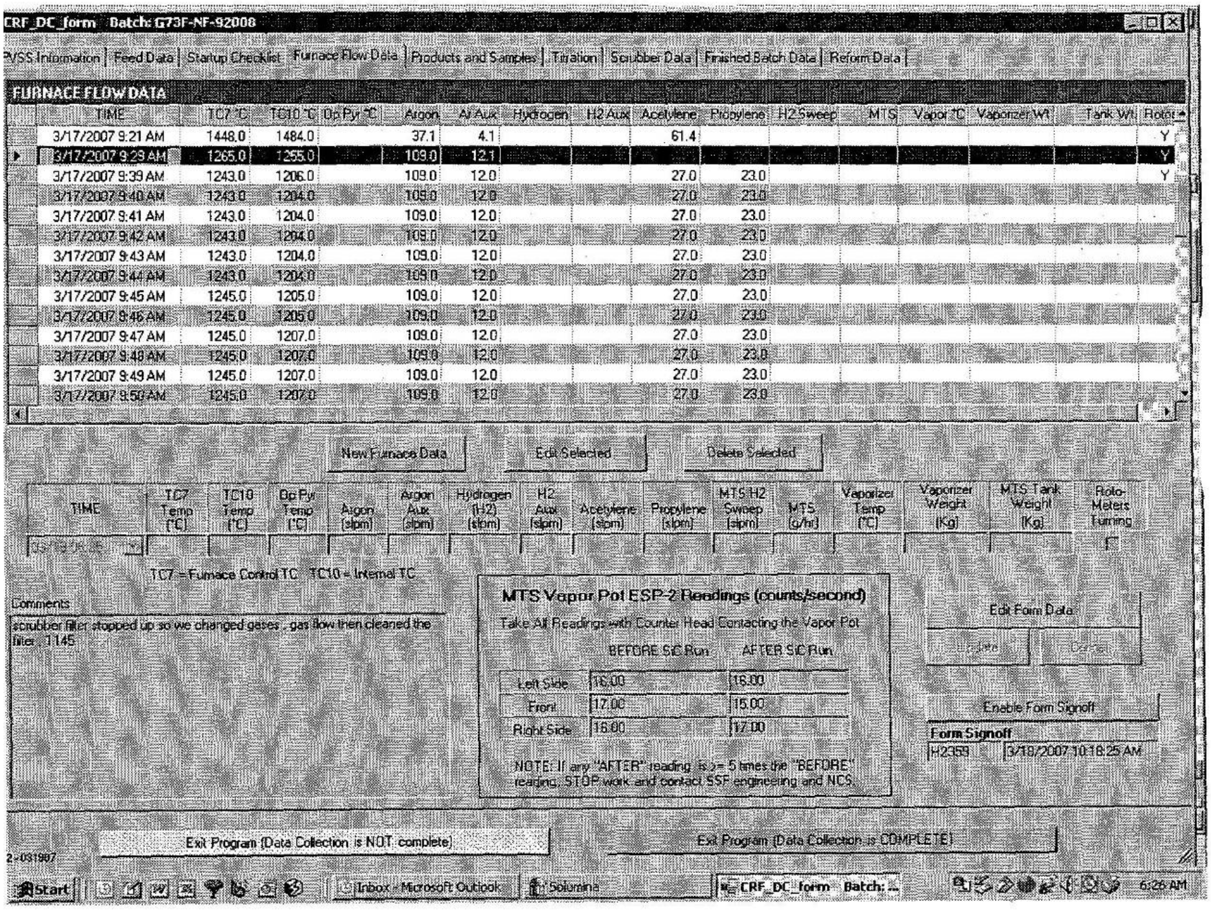
Exit Program (Data Collection is COMPLETE)
Start
Inbox - Microsoft Outlook
Solumina
CRF_DC_form Batch: ...
6:26 AM


CRF_DC_form Batch: G73F-NF-92008
PVSS Information
Feed Data
Startup Checklist
Furnace Flow Data
Products and Samples
Titration
Scrubber Data
Finished Batch Data
Reform Data
FURNACE FLOW DATA
TIME TC7 °C TC10 °C Op Pyr °C Argon Ar Aux Hydrogen H2 Aux Acetylene Propylene H2 Sweep MTS Vapor °C Vaporizer Wt Tank Wt Rotor
3/17/2007 9:21 AM 1448.0 1484.0 37.1 4.1 61.4 Y
3/17/2007 9:29 AM 1265.0 1255.0 109.0 12.1 Y
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3/17/2007 9:50 AM 1245.0 1207.0 109.0 12.0 27.0 23.0
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Edit Selected
Delete Selected
TIME
TC7 Temp (°C)
TC10 Temp (°C)
Op Pyr Temp (°C)
Argon (slpm)
Argon Aux (slpm)
Hydrogen (H2) (slpm)
H2 Aux (slpm)
Acetylene (slpm)
Propylene (slpm)
MTS H2 Sweep (slpm)
MTS (g/hr)
Vaporizer Temp (°C)
Vaporizer Weight (Kg)
MTS Tank Weight (Kg)
Roto-Meters Turning
TC7 = Furnace Control TC TC10 = Internal TC
Comments
scrubber filter stopped up so we changed gases , gas flow then cleaned the filter . 1145
MTS Vapor Pot ESP-2 Readings (counts/second)
Take All Readings with Counter Head Contacting the Vapor Pot
BEFORE SiC Run AFTER SiC Run
Left Side 16.00 16.00
Front 17.00 15.00
Right Side 16.00 17.00
NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.
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Form Signoff
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Exit Program (Data Collection is COMPLETE)
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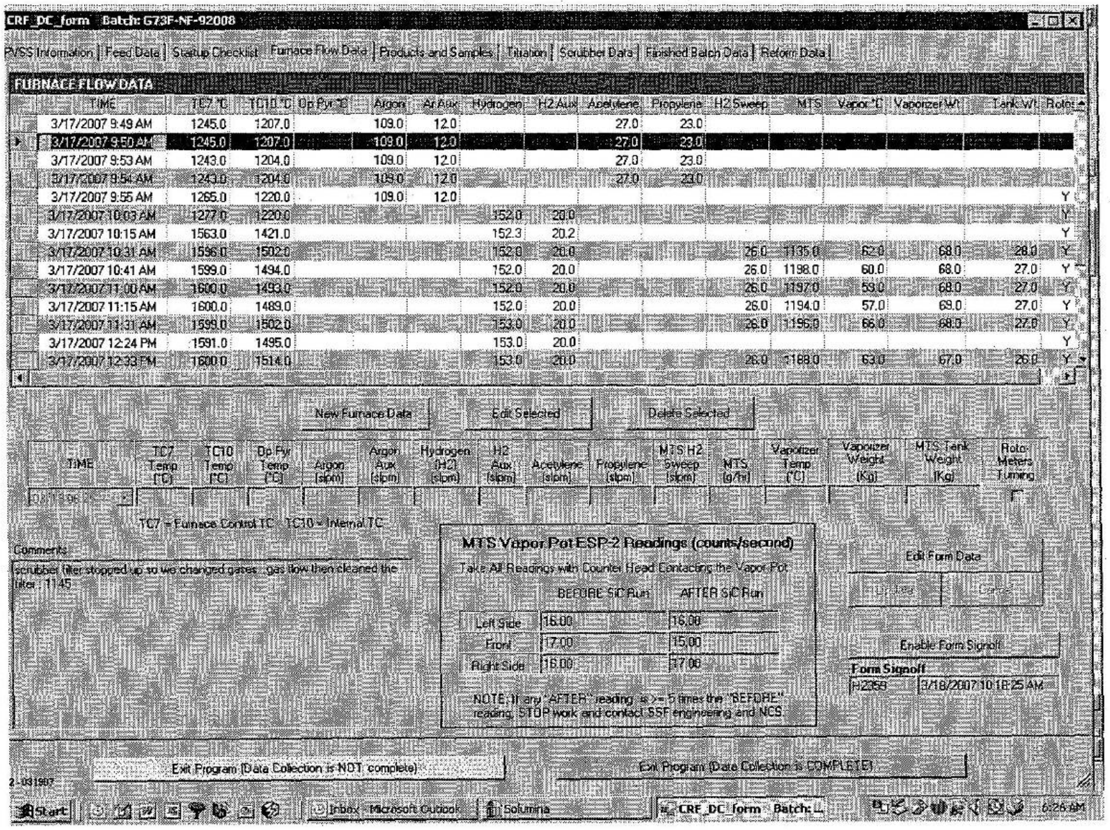
Start
Inbox - Microsoft Outlook
Solumina
CRF_DC_form Batch: ...
6:26 AM



CRF_DC_form Batch: G73F-NF-92008

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotor
3/17/2007 9:49 AM	1245.0	1207.0		109.0	12.0			27.0	23.0						
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3/17/2007 9:53 AM	1243.0	1204.0		109.0	12.0			27.0	23.0						
3/17/2007 9:54 AM	1243.0	1204.0		109.0	12.0			27.0	23.0						
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3/17/2007 10:15 AM	1563.0	1421.0				152.3	20.2								Y
3/17/2007 10:31 AM	1596.0	1502.0				152.0	20.0			26.0	1135.0	62.0	68.0	28.0	Y
3/17/2007 10:41 AM	1599.0	1494.0				152.0	20.0			26.0	1198.0	60.0	68.0	27.0	Y
3/17/2007 11:00 AM	1600.0	1493.0				152.0	20.0			26.0	1197.0	59.0	68.0	27.0	Y
3/17/2007 11:15 AM	1600.0	1489.0				152.0	20.0			26.0	1194.0	57.0	69.0	27.0	Y
3/17/2007 11:31 AM	1599.0	1502.0				153.0	20.0			26.0	1196.0	66.0	68.0	27.0	Y
3/17/2007 12:24 PM	1591.0	1495.0				153.0	20.0								Y
3/17/2007 12:33 PM	1600.0	1514.0				153.0	20.0			26.0	1188.0	63.0	67.0	26.0	Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Turning

TC7 = Furnace Control TC TC10 = Internal TC

Comments:

scrubber filter stopped up so we changed gases ..gas flow then cleaned the filter ..1145

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	16.00	16.00
Front	17.00	15.00
Right Side	16.00	17.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data

Update Cancel

Enable Form Signoff

Form Signoff

H2358 3/18/2007 10:18:25 AM

Exit Program (Data Collection is NOT complete)

Exit Program (Data Collection is COMPLETE)

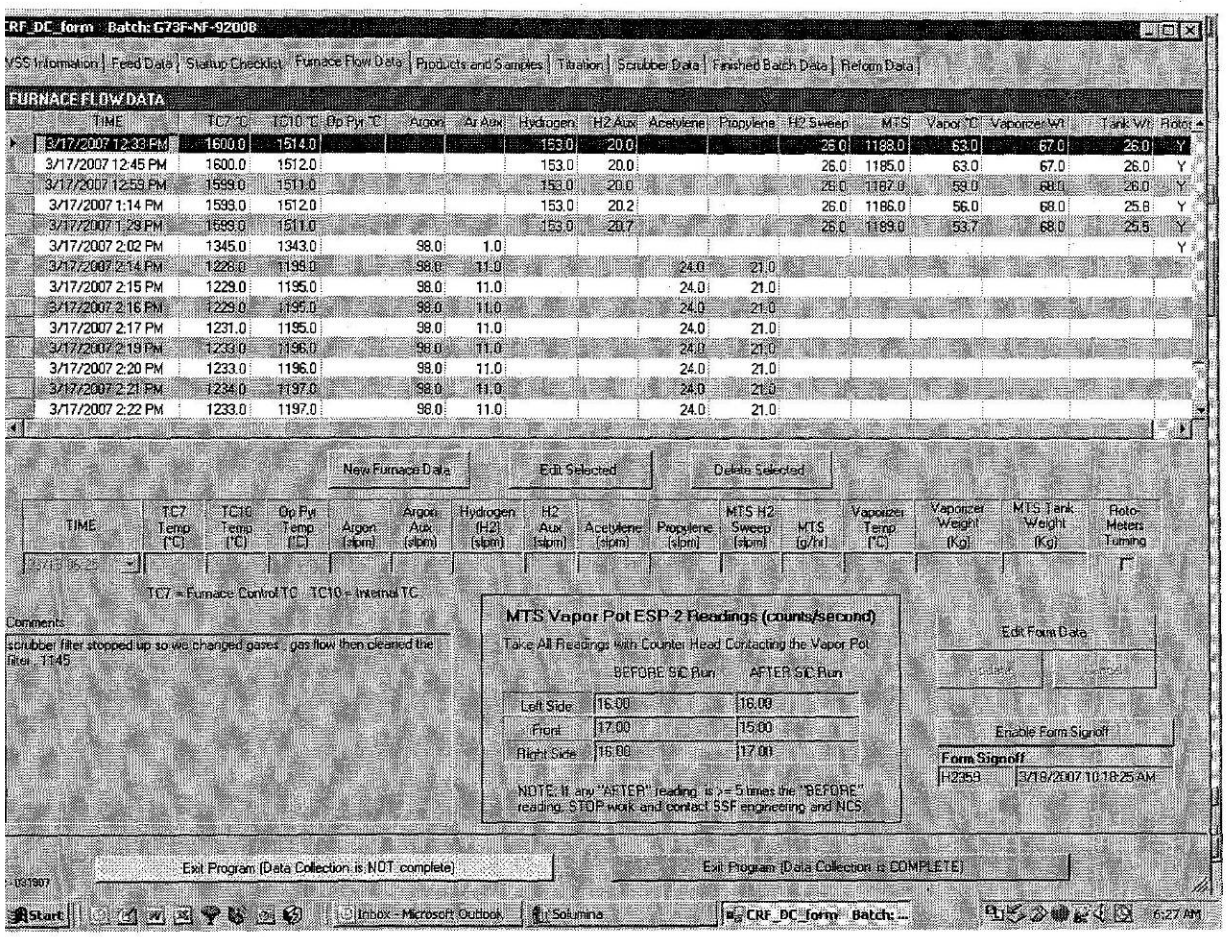
2-031907

Start Inbox - Microsoft Outlook Solumina CRF_DC_form Batch: ... 6:26 AM

THE SCRUBBER STRAINER PLUGGED 68 MINUTES INTO THE SiC COATING. SWITCHED TO ARGON, SWITCHED TO SOOT FILTER, CLEANED STRAINER, AND RESUMED SiC COATING TO COMPLETION.

Bruce Tomli

3-19-07



CRF_DC_form Batch: G73F-NF-92008

VSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/17/2007 12:33 PM	1600.0	1514.0				153.0	20.0			26.0	1188.0	63.0	67.0	26.0	Y
3/17/2007 12:45 PM	1600.0	1512.0				153.0	20.0			26.0	1185.0	63.0	67.0	26.0	Y
3/17/2007 12:59 PM	1599.0	1511.0				153.0	20.0			26.0	1187.0	59.0	68.0	26.0	Y
3/17/2007 1:14 PM	1599.0	1512.0				153.0	20.2			26.0	1186.0	56.0	68.0	25.8	Y
3/17/2007 1:29 PM	1599.0	1511.0				153.0	20.7			26.0	1189.0	53.7	68.0	25.5	Y
3/17/2007 2:02 PM	1345.0	1343.0		98.0	1.0										Y
3/17/2007 2:14 PM	1228.0	1199.0		98.0	11.0			24.0	21.0						
3/17/2007 2:15 PM	1229.0	1195.0		98.0	11.0			24.0	21.0						
3/17/2007 2:16 PM	1229.0	1195.0		98.0	11.0			24.0	21.0						
3/17/2007 2:17 PM	1231.0	1195.0		98.0	11.0			24.0	21.0						
3/17/2007 2:19 PM	1233.0	1196.0		98.0	11.0			24.0	21.0						
3/17/2007 2:20 PM	1233.0	1196.0		98.0	11.0			24.0	21.0						
3/17/2007 2:21 PM	1234.0	1197.0		98.0	11.0			24.0	21.0						
3/17/2007 2:22 PM	1233.0	1197.0		98.0	11.0			24.0	21.0						

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Turning

TC7 = Furnace Control TC TC10 = Internal TC

Comments

scrubber filter stopped up so we changed gases , gas flow then cleaned the filter , 1145

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	16.00	16.00
Front	17.00	15.00
Right Side	16.00	17.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data

Update | Cancel

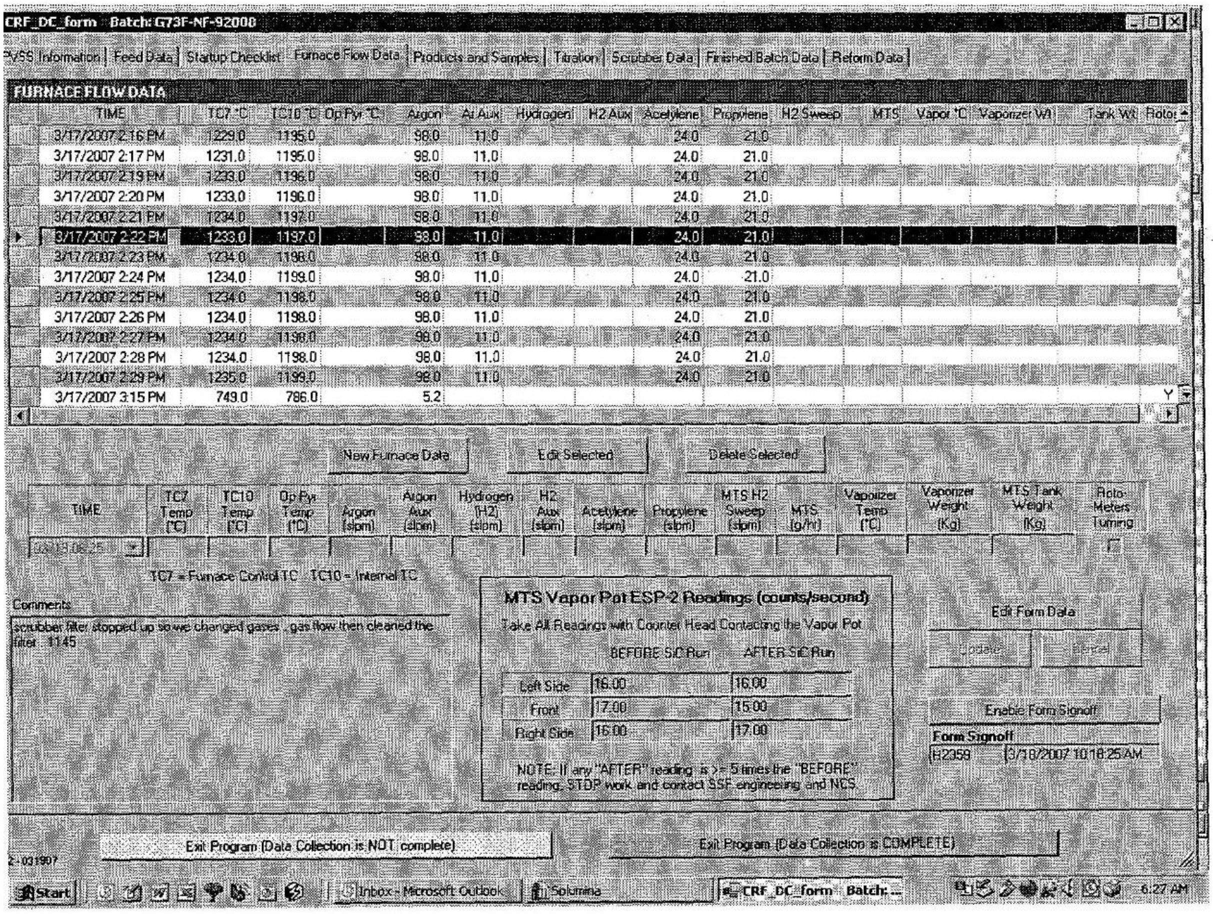
Enable Form Signoff

Form Signoff

H2359 | 3/18/2007 10:18:25 AM

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch: ... | 6:27 AM



CRF_DC_form Batch: G73F-NF-92000

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Roto
3/17/2007 2:16 PM	1229.0	1195.0		98.0	11.0			24.0	21.0						
3/17/2007 2:17 PM	1231.0	1195.0		98.0	11.0			24.0	21.0						
3/17/2007 2:19 PM	1233.0	1196.0		98.0	11.0			24.0	21.0						
3/17/2007 2:20 PM	1233.0	1196.0		98.0	11.0			24.0	21.0						
3/17/2007 2:21 PM	1234.0	1197.0		98.0	11.0			24.0	21.0						
3/17/2007 2:22 PM	1233.0	1197.0		98.0	11.0			24.0	21.0						
3/17/2007 2:23 PM	1234.0	1198.0		98.0	11.0			24.0	21.0						
3/17/2007 2:24 PM	1234.0	1199.0		98.0	11.0			24.0	21.0						
3/17/2007 2:25 PM	1234.0	1198.0		98.0	11.0			24.0	21.0						
3/17/2007 2:26 PM	1234.0	1198.0		98.0	11.0			24.0	21.0						
3/17/2007 2:27 PM	1234.0	1198.0		98.0	11.0			24.0	21.0						
3/17/2007 2:28 PM	1234.0	1198.0		98.0	11.0			24.0	21.0						
3/17/2007 2:29 PM	1235.0	1199.0		98.0	11.0			24.0	21.0						
3/17/2007 3:15 PM	749.0	786.0		5.2											Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Tuning
[illegible]															

TC7 = Furnace Control TC TC10 = Internal TC

Comments

scrubber filter stopped up so we changed gases , gas flow then cleaned the filter 1145

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	16.00	16.00
Front	17.00	15.00
Right Side	16.00	17.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS

Edit Form Data

Update | Cancel

Enable Form Signoff

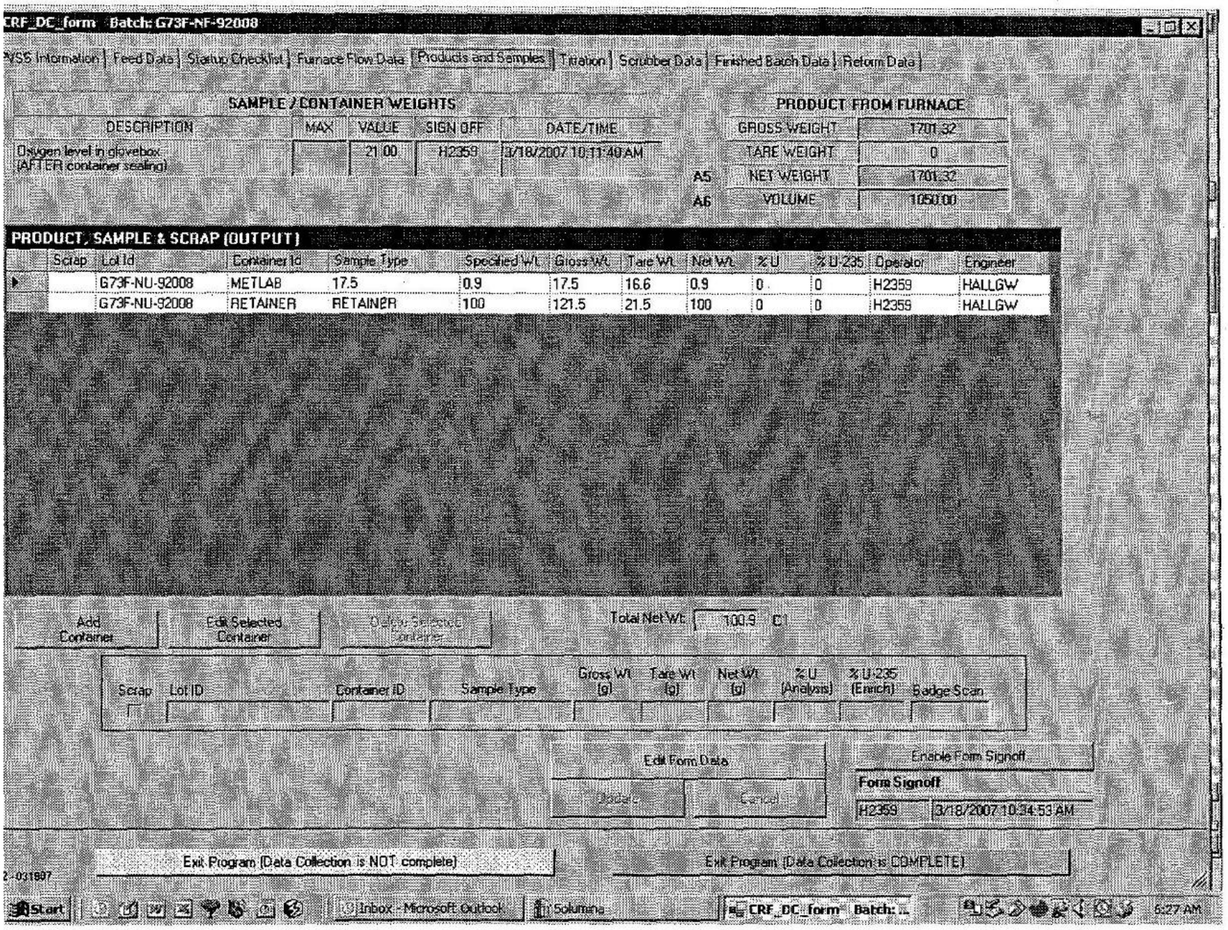
Form Signoff

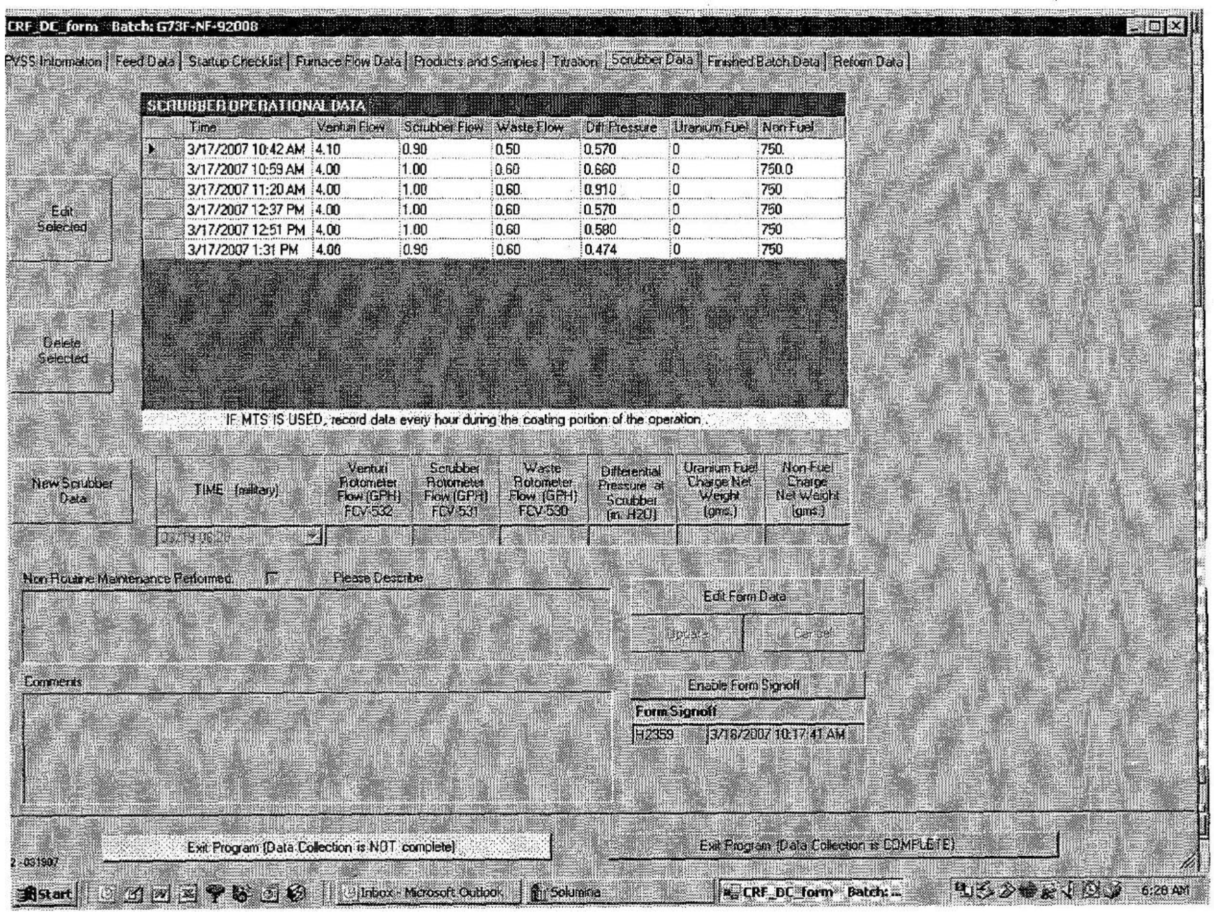
H2359 3/18/2007 10:18:25 AM

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

2-031907

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch: ... 6:27 AM


CRF_DC_form Batch: G73F-NF-92008
SAMPLE / CONTAINER WEIGHTS
DESCRIPTION
MAX
VALUE
SIGN OFF
DATE/TIME
Oxygen level in glovebox (AFTER container sealing)
21.00
H2359
3/18/2007 10:11:40 AM
PRODUCT FROM FURNACE
GROSS WEIGHT
1701.32
TARE WEIGHT
0
A5
NET WEIGHT
1701.32
A6
VOLUME
1050.00
PRODUCT, SAMPLE & SCRAP (OUTPUT)
Scrap
Lot Id
Container Id
Sample Type
Specified Wt.
Gross Wt.
Tare Wt.
Net Wt.
% U
% U-235
Operator
Engineer
G73F-NU-92008
METLAB
17.5
0.9
17.5
16.6
0.9
0
0
H2359
HALLGW
G73F-NU-92008
RETAINER
RETAINER
100
121.5
21.5
100
0
0
H2359
HALLGW
Add Container
Edit Selected Container
Total Net Wt:
100.9
Edit Form Data
Enable Form Signoff
Form Signoff
H2359
3/18/2007 10:34:53 AM
Exit Program (Data Collection is NOT complete)
Exit Program (Data Collection is COMPLETE)


CRF_DC_form Batch: G73F-NF-92008

PYSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

SCRUBBER OPERATIONAL DATA

Time	Venturi Flow	Scrubber Flow	Waste Flow	Diff Pressure	Uranium Fuel	Non Fuel
3/17/2007 10:42 AM	4.10	0.90	0.50	0.570	0	750.
3/17/2007 10:59 AM	4.00	1.00	0.60	0.660	0	750.0
3/17/2007 11:20 AM	4.00	1.00	0.60	0.910	0	750
3/17/2007 12:37 PM	4.00	1.00	0.60	0.570	0	750
3/17/2007 12:51 PM	4.00	1.00	0.60	0.580	0	750
3/17/2007 1:31 PM	4.00	0.90	0.60	0.474	0	750

Edit Selected

Delete Selected

IF MTS IS USED, record data every hour during the coating portion of the operation.

New Scrubber Data

TIME (military)	Venturi Rotometer Flow (GPH) FCV-532	Scrubber Rotometer Flow (GPH) FCV-531	Waste Rotometer Flow (GPH) FCV-530	Differential Pressure at Scrubber (in. H2O)	Uranium Fuel Charge Net Weight (gms.)	Non-Fuel Charge Net Weight (gms.)

Non Routine Maintenance Performed: Please Describe

Comments

Edit Form Data

Update Cancel

Enable Form Signoff

Form Signoff

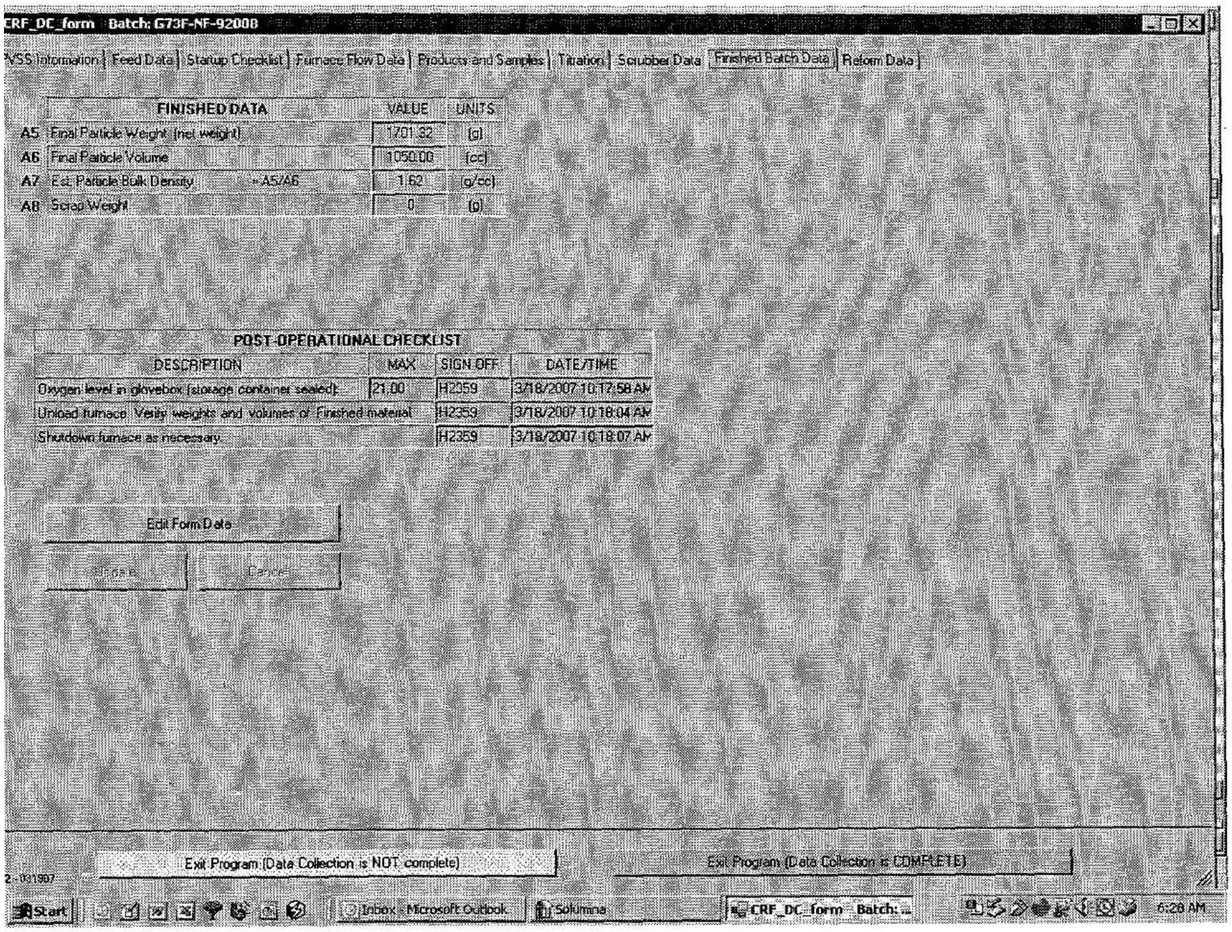
H2359 3/18/2007 10:17:41 AM

Exit Program (Data Collection is NOT complete)

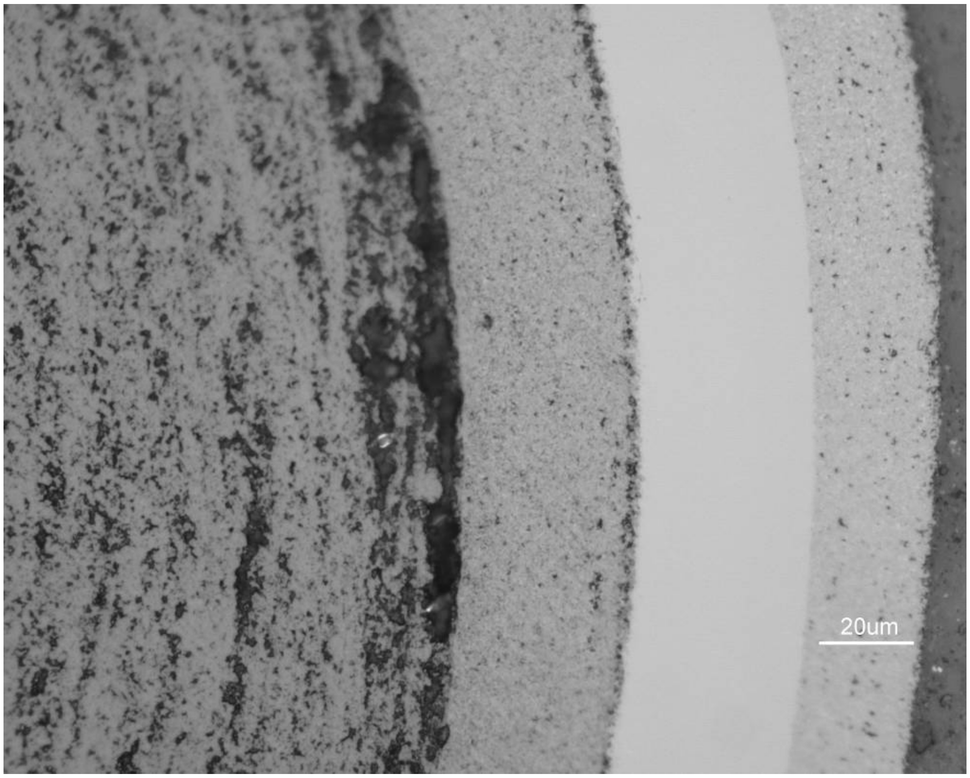
Exit Program (Data Collection is COMPLETE)

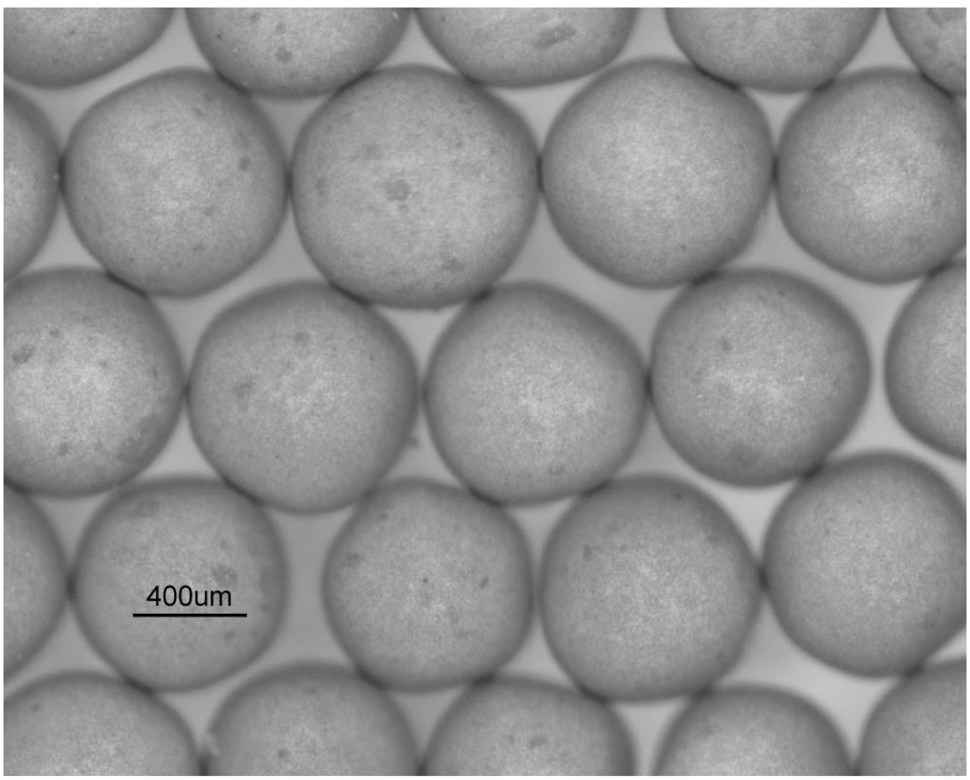
2-031907

Start Inbox - Microsoft Outlook Solumina CRF_DC_form Batch: ... 6:28 AM


CRF_DC_form Batch: G73F-NF-92008
VSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data
FINISHED DATA
VALUE
UNITS
A5 Final Particle Weight (net weight) 1701.32 (g)
A6 Final Particle Volume 1050.00 (cc)
A7 Est. Particle Bulk Density = A5/A6 1.62 (g/cc)
A8 Scrap Weight 0 (g)
POST-OPERATIONAL CHECKLIST
DESCRIPTION
MAX
SIGN OFF
DATE/TIME
Oxygen level in glovebox (storage container sealed): 21.00 H2359 3/18/2007 10:17:58 AM
Unload furnace. Verify weights and volumes of Finished material. H2359 3/18/2007 10:18:04 AM
Shutdown furnace as necessary. H2359 3/18/2007 10:18:07 AM
Edit Form Data
Cancel
Exit Program (Data Collection is NOT complete)
Exit Program (Data Collection is COMPLETE)
Start
Inbox - Microsoft Outlook
Solumina
CRF_DC_form Batch: ...
6:28 AM

Batch 92008 Particle Photos





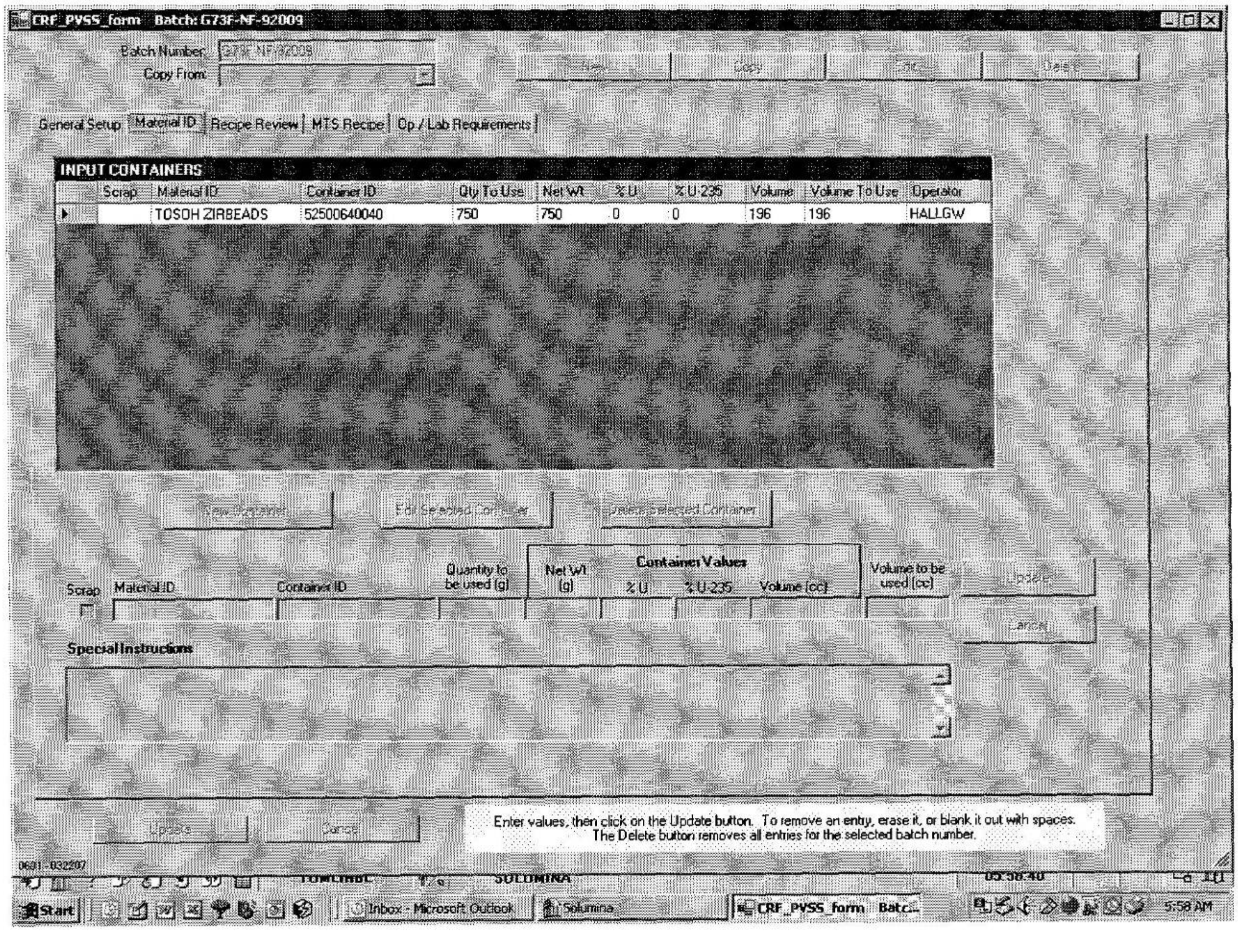
Run ID Buffer Substrate Input	Acetylene
Substrate ID	Zirbeads
Substrate Weight (g)	750
Substrate Diameter (µ)	400
Substrate Diameter (cm)	0.04
Substrate Density (abs - g/cc)	6.00
Est. Volume (cc)	208.33
Coating Data	
TOTAL Thickness (cm)	0.01
Substrate plus buffer thickness (cm)	0.06
Carbon Density	1.0
Wt. Carbon Needed (g)	296.88
Assumed Bed Eff. (%)	62.0%
Carbon To Use (g)	478.8
Acetylene Needed (g)	518.73
Acetylene Needed (l)	487.3
Run Setup Parameters	
Initial Coating Rate (microns/min)	13.2
Initial Coating Thickness (um)	100
Initial Coating Time (minutes)	7.58
Acetylene for Initial Coat (l)	407.3
Initial C2H2 Flowrate (lpm)	61.69
Total Gas Flow (lpm)	102.81
Minimum Argon Flow (lpm)	41.12
Argon Flow - Annular (lpm)	4.11
Argon Flow - Fluidization (lpm)	37.01

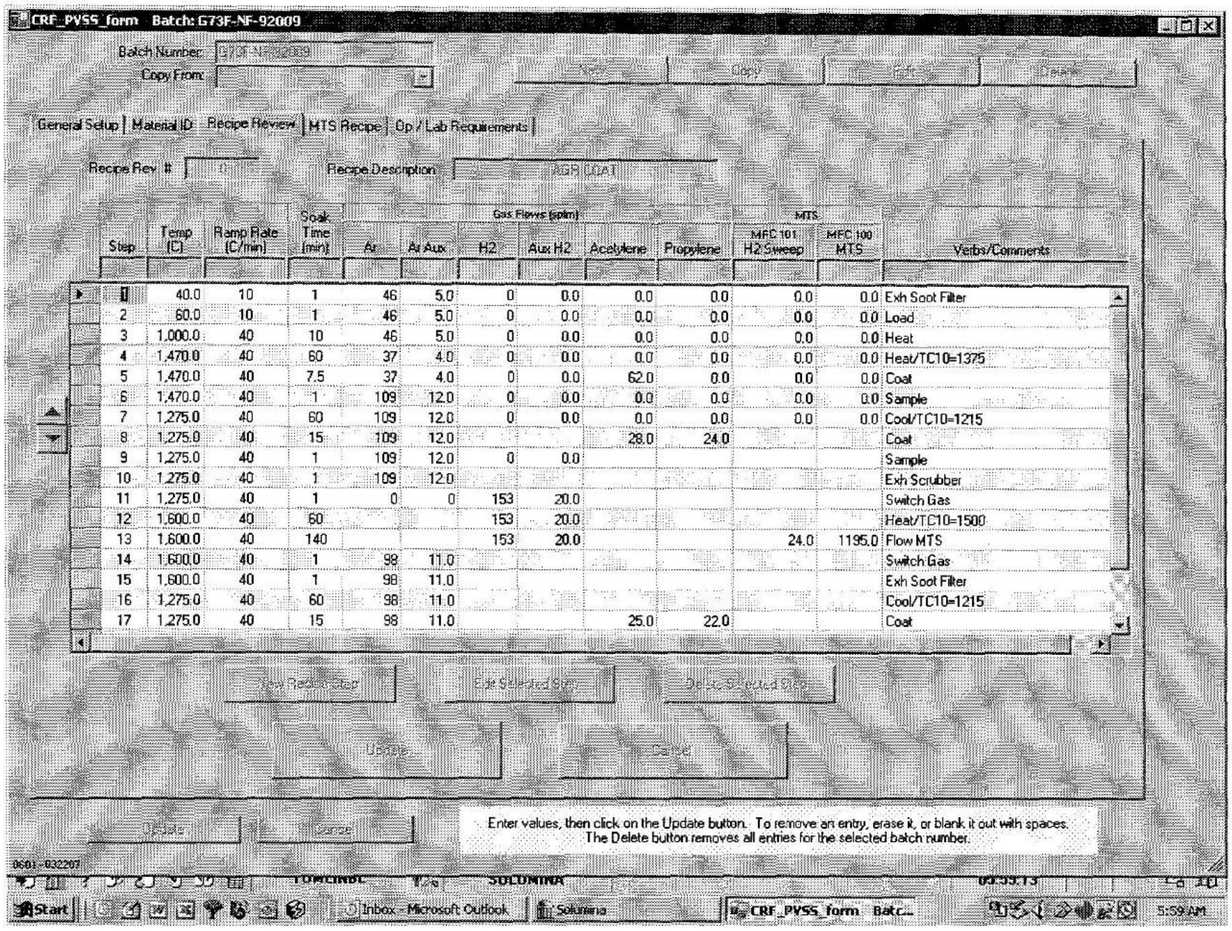
Run ID IPyC Substrate Input	Propylene
Substrate ID	Zirbeads
Substrate Weight (g)	1046.9
Substrate Diameter (cm)	0.06
Substrate Density (abs - g/cc)	2.52
Est. Volume (cc)	692.38
Coating Data	
TOTAL Thickness (cm)	0.004
Substrate plus IPyC thickness (cm)	0.068
Carbon Density	1.9
Prop Flow	46%
Wt. Carbon Needed (g)	365.3
Assumed Bed Eff. (%)	42.0%
Carbon To Use (g)	869.7
Acet/Prop Needed (g)	982.83
Acet Flow	54.0%
Acet/Prop Needed (l)	767.7
Run Setup Parameters	
Initial Coating Rate (microns/min)	2.7
Initial Coating Thickness (µm)	40
Initial Coating Time (minutes)	14.81
Acet/Prop for Initial Coat (l)	707.7
Initial C2H2 Flow (lpm)	27.98
Initial C3H6 Flowrate (lpm)	23.84
Total Gas Flow (lpm)	172.74
Minimum Argon Flow (lpm)	120.92
Argon Flow - Annular (lpm)	12.09
Argon Flow - Fluidization (lpm)	108.83

Run ID SiC Substrate Input	MTS
Substrate ID	Zirbeads
Substrate Weight (g)	1412.2
Substrate Diameter (cm)	0.068
Substrate Density (abs - g/cc)	2.32
Est. Volume (cc)	1014.48
Coating Data	
TOTAL Thickness (cm)	0.0035
Substrate plus SiC thickness (cm)	0.075
Silicon Carbide Density (g/cc)	3.20
MTS Density (g/cc)	1.273
Wt. SiC Needed (g)	871.5
Assumed Bed Eff. (%)	90.0%
MTS To Use (g)	2509.0
MTS Needed (g)	2788.67
Vol MTS Needed (cc) liquid	2190.63
MTS Needed (l) liquid	2.191
Run Setup Parameters	
Initial Coating Rate (microns/min)	0.25
Initial Coating Thickness (µm)	35
Initial Coating Time (minutes)	140.00
MTS for Initial Coat (g)	2788.67
Initial MTS Flowrate (g/hr)	1195.14
Moles MTS Needed	18.65
Volume MTS Gas Needed (l)	417.83
MTS Gas Flow Rate (lpm)	2.98
Total Gas Flow (lpm)	198.97
Minimum Hydrogen Flow (lpm)	195.98
MTS Sweep Flow (lpm)	23.86
Annular Flow (lpm)	19.60
Hydrogen Flow (lpm)	152.51

Run ID OPyC Substrate Input	Propylene
Substrate ID	Zirbeads
Substrate Weight (g)	2083.7
Substrate Diameter (cm)	0.075
Substrate Density (abs - g/cc)	2.54
Est. Volume (cc)	1367.24
Coating Data	
TOTAL Thickness (cm)	0.004
Substrate plus OpyC thickness (cm)	0.083
Carbon Density	1.9
Prop Flow	46%
Wt. Carbon Needed (g)	556.3
Assumed Bed Eff. (%)	42.0%
Carbon To Use (g)	1324.6
Acet/Prop Needed (g)	1406.86
Acet Flow	54.0%
Acet/Prop Needed (l)	1169.2
Run Setup Parameters	
Initial Coating Rate (microns/min)	1.6
Initial Coating Thickness (µm)	40
Initial Coating Time (minutes)	25.00
Acet/Prop for Initial Coat (l)	1169.2
Initial C2H2 Flow (lpm)	25.26
Initial C3H6 Flowrate (lpm)	21.51
Total Gas Flow (lpm)	155.90
Minimum Argon Flow (lpm)	109.13
Argon Flow - Annular (lpm)	10.91
Argon Flow - Fluidization (lpm)	98.22

x=propylene
y=acetylene
x/y = 0.85 x=.85y
x + y = 1.0
.85y + y = 1
y = 1/1.85
y = 0.54
x = 1 - 0.54 = 0.46


CRF_PVSS_form Batch: G73F-NF-92009
Batch Number: G73F-NF-92009
Copy From:
New
Copy
Delete
General Setup
Material ID
Recipe Review
MTS Recipe
Op / Lab Requirements
INPUT CONTAINERS
Scrap
Material ID
Container ID
Qty To Use
Net Wt
% U
% U-235
Volume
Volume To Use
Operator
TOSOH ZIRBEADS
52500640040
750
750
0
0
196
196
HALLGW
New Container
Edit Selected Container
Delete Selected Container
Container Values
Quantity to be used (g)
Net Wt (g)
Volume to be used (cc)
% U
% U-235
Volume (cc)
Update
Cancel
Special Instructions
Enter values, then click on the Update button. To remove an entry, erase it, or blank it out with spaces.
The Delete button removes all entries for the selected batch number.
Start
Inbox - Microsoft Outlook
Solumina
CRF_PVSS_form Batc...
5:58 AM



CRF_PVSS_form Batch: G73F-NF-92009

Batch Number: G73F-NF-92009

Copy From:

New | Copy | Edit | Delete

General Setup | Material ID | Recipe Review | MTS Recipe | Op / Lab Requirements

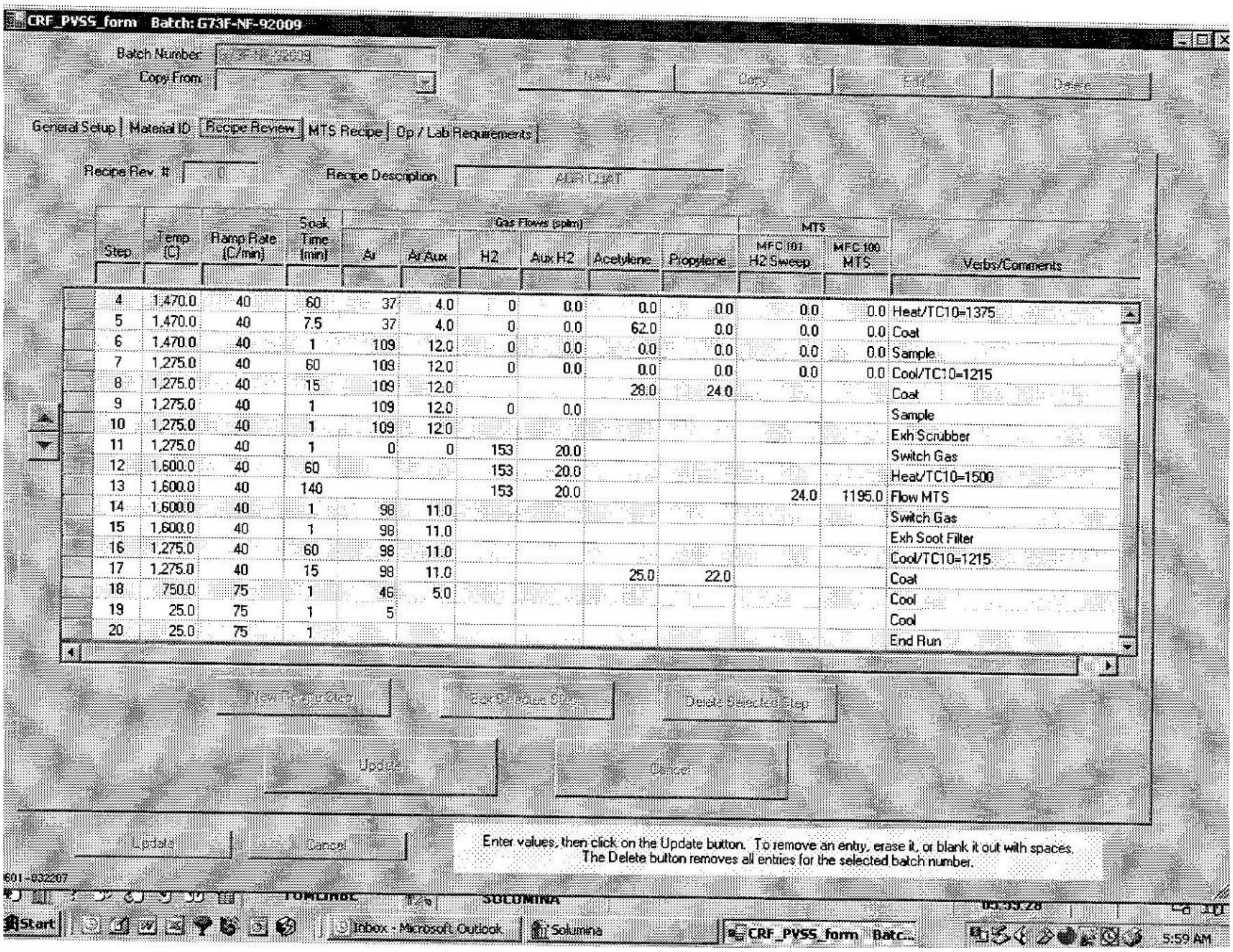
Recipe Rev # 0 Recipe Description AGR COAT

				Gas Flows (slpm)						MTS		
Step	Temp (C)	Ramp Rate (C/min)	Soak Time (min)	Ar	Ar Aux	H2	Aux H2	Acetylene	Propylene	MFC 101 H2 Sweep	MFC 100 MTS	Verbs/Comments
1	40.0	10	1	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Exh Soot Filter
2	60.0	10	1	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Load
3	1,000.0	40	10	46	5.0	0	0.0	0.0	0.0	0.0	0.0	Heat
4	1,470.0	40	60	37	4.0	0	0.0	0.0	0.0	0.0	0.0	Heat/TC10=1375
5	1,470.0	40	7.5	37	4.0	0	0.0	62.0	0.0	0.0	0.0	Coat
6	1,470.0	40	1	109	12.0	0	0.0	0.0	0.0	0.0	0.0	Sample
7	1,275.0	40	60	109	12.0	0	0.0	0.0	0.0	0.0	0.0	Cool/TC10=1215
8	1,275.0	40	15	109	12.0			28.0	24.0			Coat
9	1,275.0	40	1	109	12.0	0	0.0					Sample
10	1,275.0	40	1	109	12.0							Exh Scrubber
11	1,275.0	40	1	0	0	153	20.0					Switch Gas
12	1,600.0	40	60			153	20.0					Heat/TC10=1500
13	1,600.0	40	140			153	20.0			24.0	1195.0	Flow MTS
14	1,600.0	40	1	98	11.0							Switch Gas
15	1,600.0	40	1	98	11.0							Exh Soot Filter
16	1,275.0	40	60	98	11.0							Cool/TC10=1215
17	1,275.0	40	15	98	11.0			25.0	22.0			Coat

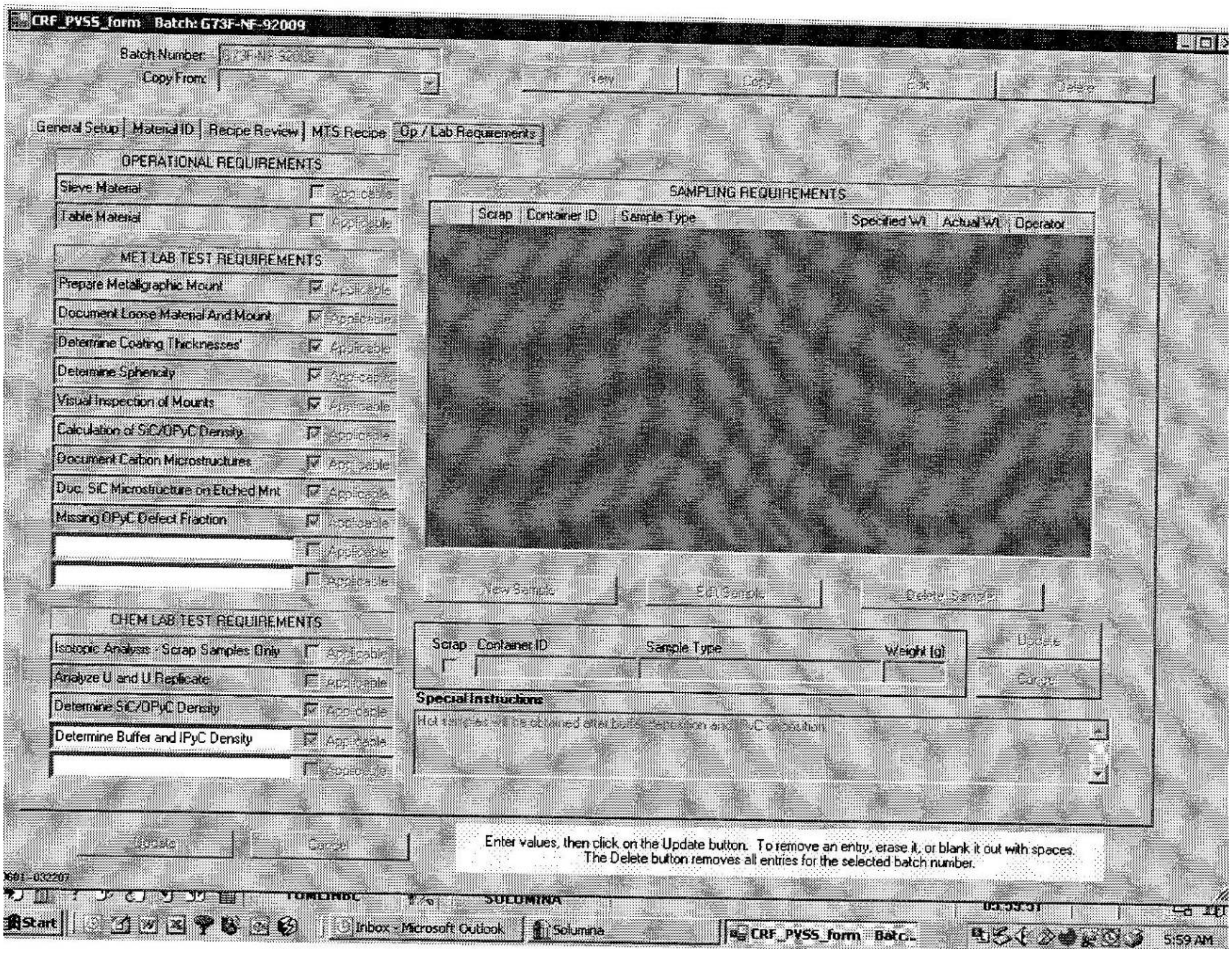
Update | Cancel

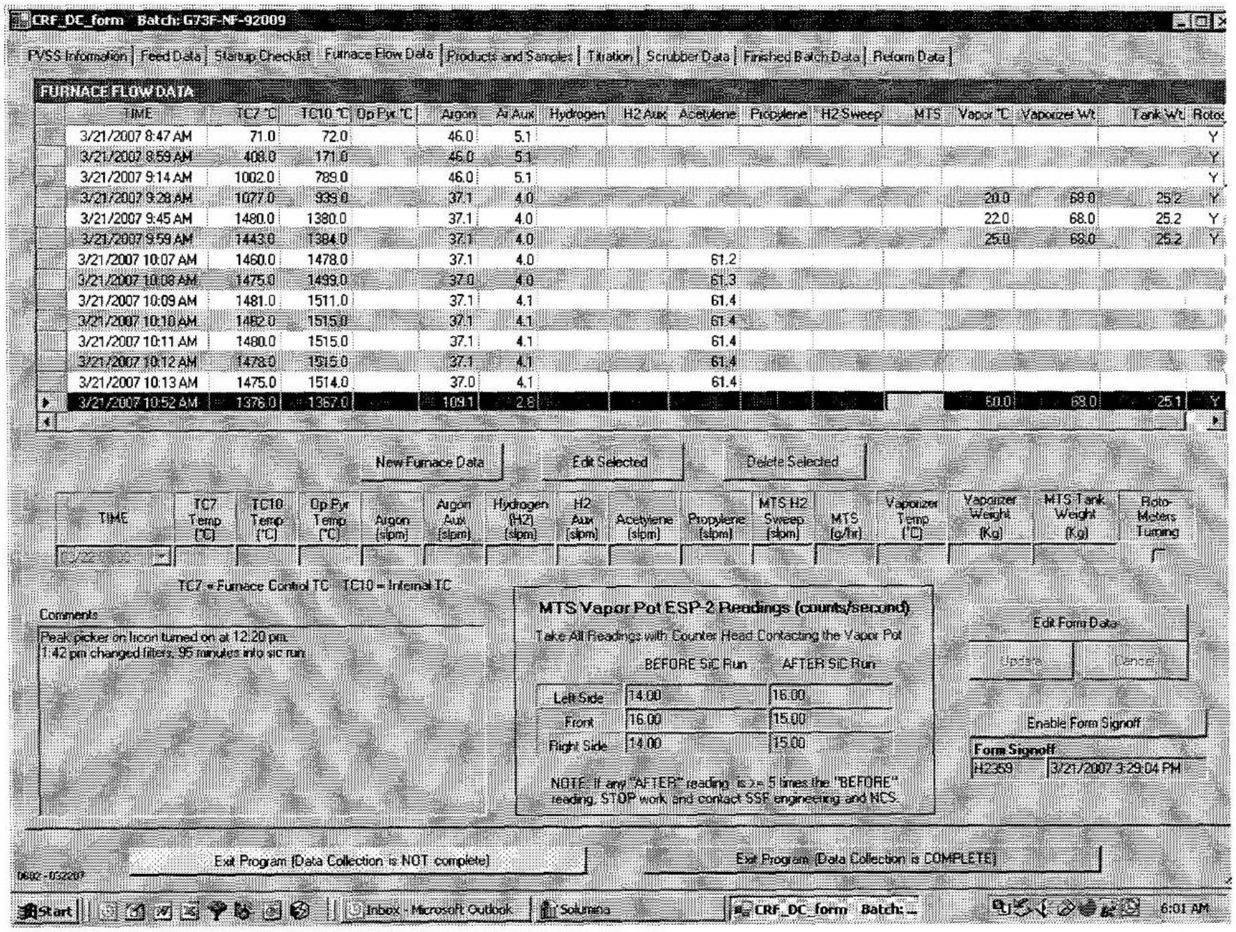
Enter values, then click on the Update button. To remove an entry, erase it, or blank it out with spaces. The Delete button removes all entries for the selected batch number.

Start | Inbox - Microsoft Outlook | Solumina | CRF_PVSS_form Batc... 5:59 AM



Step	Temp (C)	Ramp Rate (C/min)	Soak Time (min)	Ar	Ar Aux	H2	Aux H2	Acetylene	Propylene	MFC 101 H2 Sweep	MFC 100 MTS	Verbs/Comments
4	1,470.0	40	60	37	4.0	0	0.0	0.0	0.0	0.0	0.0	Heat/TC10=1375
5	1,470.0	40	7.5	37	4.0	0	0.0	62.0	0.0	0.0	0.0	Coat
6	1,470.0	40	1	109	12.0	0	0.0	0.0	0.0	0.0	0.0	Sample
7	1,275.0	40	60	109	12.0	0	0.0	0.0	0.0	0.0	0.0	Cool/TC10=1215
8	1,275.0	40	15	109	12.0			28.0	24.0			Coat
9	1,275.0	40	1	109	12.0	0	0.0					Sample
10	1,275.0	40	1	109	12.0							Exh Scrubber
11	1,275.0	40	1	0	0	153	20.0					Switch Gas
12	1,600.0	40	60			153	20.0					Heat/TC10=1500
13	1,600.0	40	140			153	20.0			24.0	1195.0	Flow MTS
14	1,600.0	40	1	98	11.0							Switch Gas
15	1,600.0	40	1	98	11.0							Exh Soot Filter
16	1,275.0	40	60	98	11.0							Cool/TC10=1215
17	1,275.0	40	15	98	11.0			25.0	22.0			Coat
18	750.0	75	1	46	5.0							Cool
19	25.0	75	1	5								Cool
20	25.0	75	1									End Run


CRF_PVSS_form Batch: G73F-NF-92009
Batch Number:
Copy From:
New
Copy
Exit
Delete
General Setup
Material ID
Recipe Review
MTS Recipe
Op / Lab Requirements
OPERATIONAL REQUIREMENTS
Sieve Material
Table Material
MET LAB TEST REQUIREMENTS
Prepare Metallographic Mount
Document Loose Material And Mount
Determine Coating Thicknesses
Determine Sphericity
Visual Inspection of Mounts
Calculation of SiC/OPyC Density
Document Carbon Microstructures
Doc. SiC Microstructure on Etched Mnt
Missing OPyC Defect Fraction
CHEM LAB TEST REQUIREMENTS
Isotopic Analysis - Scrap Samples Only
Analyze U and U Replicate
Determine SiC/OPyC Density
Determine Buffer and IPyC Density
Applicable
SAMPLING REQUIREMENTS
Scrap
Container ID
Sample Type
Specified Wt
Actual Wt
Operator
New Sample
Edit Sample
Delete Sample
Weight (g)
Update
Cancel
Special Instructions
Enter values, then click on the Update button. To remove an entry, erase it, or blank it out with spaces.
The Delete button removes all entries for the selected batch number.
Start
Inbox - Microsoft Outlook
Solumina
CRF_PVSS_form Batc...
5:59 AM



CRF_DC_form Batch: G73F-NF-92009

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/21/2007 8:47 AM	71.0	72.0		46.0	5.1										Y
3/21/2007 8:59 AM	408.0	171.0		46.0	5.1										Y
3/21/2007 9:14 AM	1002.0	789.0		46.0	5.1										Y
3/21/2007 9:28 AM	1077.0	939.0		37.1	4.0							20.0	68.0	25.2	Y
3/21/2007 9:45 AM	1480.0	1380.0		37.1	4.0							22.0	68.0	25.2	Y
3/21/2007 9:59 AM	1443.0	1384.0		37.1	4.0							25.0	68.0	25.2	Y
3/21/2007 10:07 AM	1460.0	1478.0		37.1	4.0			61.2							
3/21/2007 10:08 AM	1475.0	1499.0		37.0	4.0			61.3							
3/21/2007 10:09 AM	1481.0	1511.0		37.1	4.1			61.4							
3/21/2007 10:10 AM	1482.0	1515.0		37.1	4.1			61.4							
3/21/2007 10:11 AM	1480.0	1515.0		37.1	4.1			61.4							
3/21/2007 10:12 AM	1478.0	1515.0		37.1	4.1			61.4							
3/21/2007 10:13 AM	1475.0	1514.0		37.0	4.1			61.4							
3/21/2007 10:52 AM	1376.0	1367.0		109.1	2.8							60.0	68.0	25.1	Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Turning

TC7 = Furnace Control TC TC10 = Internal TC

Comments

Peak picker on licon turned on at 12:20 pm.
1:42 pm changed filters. 95 minutes into sic run.

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	14.00	16.00
Front	16.00	15.00
Right Side	14.00	15.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data | Update | Cancel

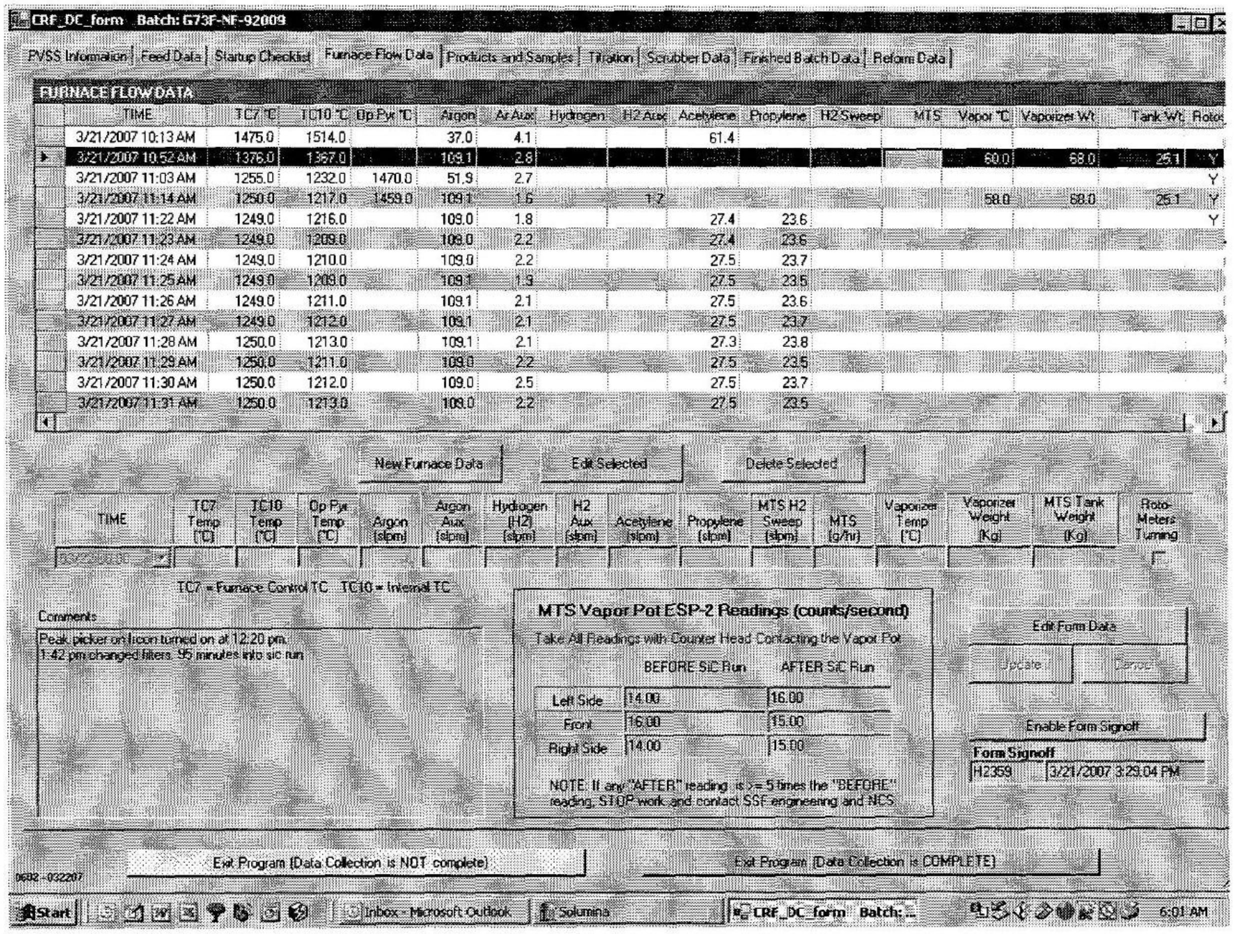
Enable Form Signoff

Form Signoff
H2359 3/21/2007 3:29:04 PM

0602 - 032207

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch: ... | 6:01 AM



CRF_DC_form Batch: G73F-NF-92009

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/21/2007 10:13 AM	1475.0	1514.0		37.0	4.1			61.4							
3/21/2007 10:52 AM	1376.0	1367.0		109.1	2.8							60.0	68.0	25.1	Y
3/21/2007 11:03 AM	1255.0	1232.0	1470.0	51.9	2.7										Y
3/21/2007 11:14 AM	1250.0	1217.0	1459.0	109.1	1.6		1.7					58.0	68.0	25.1	Y
3/21/2007 11:22 AM	1249.0	1216.0		109.0	1.8			27.4	23.6						Y
3/21/2007 11:23 AM	1249.0	1209.0		109.0	2.2			27.4	23.6						
3/21/2007 11:24 AM	1249.0	1210.0		109.0	2.2			27.5	23.7						
3/21/2007 11:25 AM	1249.0	1209.0		109.1	1.9			27.5	23.5						
3/21/2007 11:26 AM	1249.0	1211.0		109.1	2.1			27.5	23.6						
3/21/2007 11:27 AM	1249.0	1212.0		109.1	2.1			27.5	23.7						
3/21/2007 11:28 AM	1250.0	1213.0		109.1	2.1			27.3	23.8						
3/21/2007 11:29 AM	1250.0	1211.0		109.0	2.2			27.5	23.5						
3/21/2007 11:30 AM	1250.0	1212.0		109.0	2.5			27.5	23.7						
3/21/2007 11:31 AM	1250.0	1213.0		109.0	2.2			27.5	23.5						

New Furnace Data | Edit Selected | Delete Selected

TIME | TC7 Temp (°C) | TC10 Temp (°C) | Op Pyr Temp (°C) | Argon (slpm) | Argon Aux (slpm) | Hydrogen (H2) (slpm) | H2 Aux (slpm) | Acetylene (slpm) | Propylene (slpm) | MTS H2 Sweep (slpm) | MTS (g/hr) | Vaporizer Temp (°C) | Vaporizer Weight (Kg) | MTS Tank Weight (Kg) | Roto-Meters Turning

TC7 = Furnace Control TC TC10 = Internal TC

Comments

Peak picker on Icon turned on at 12:20 pm.
1:42 pm changed filters. 95 minutes into sic run

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	14.00	16.00
Front	16.00	15.00
Right Side	14.00	15.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data

Update | Cancel

Enable Form Signoff

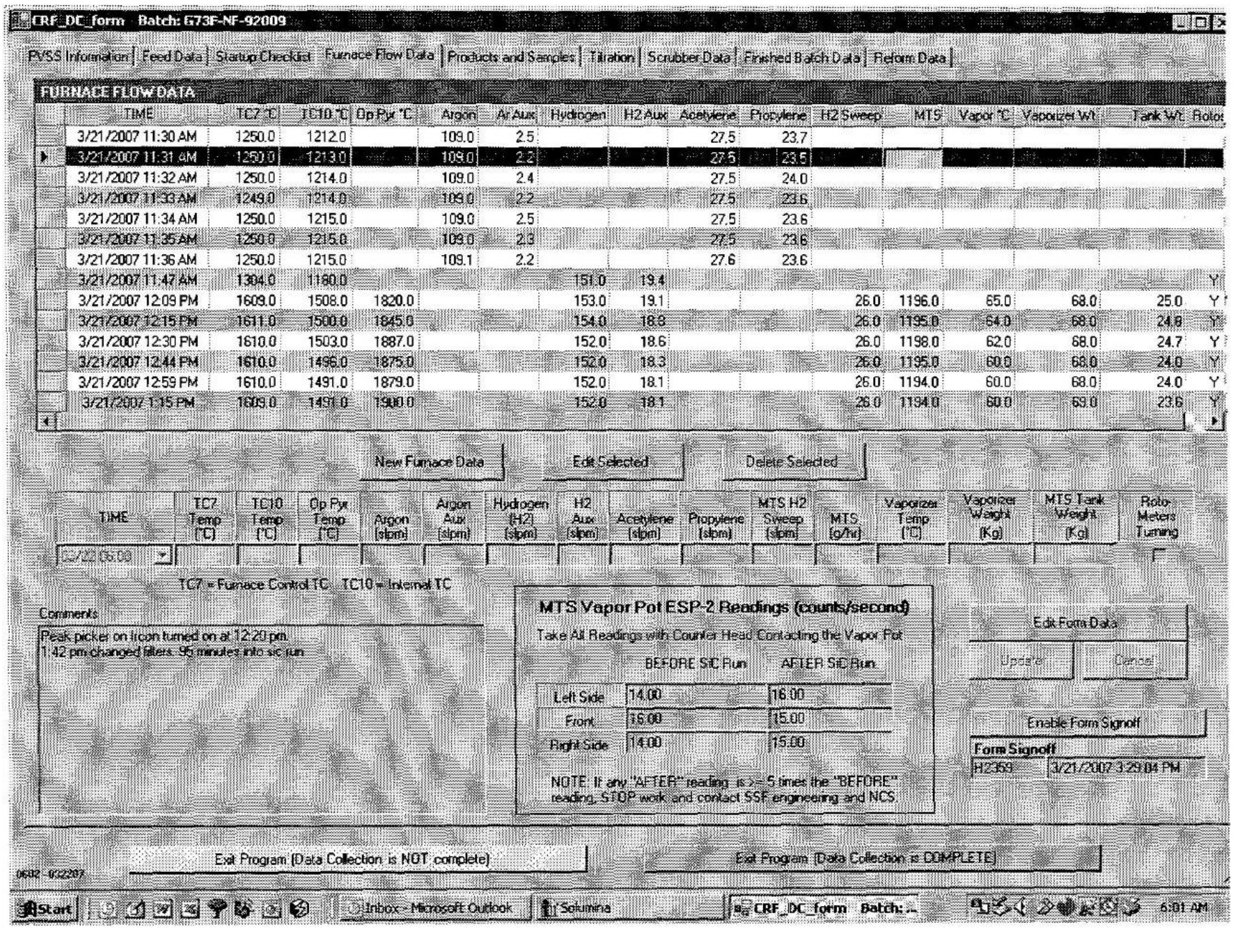
Form Signoff

H2359 | 3/21/2007 3:29:04 PM

0692 - 032207

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch: ... | 6:01 AM



CRF_DC_form Batch: G73F-NF-92009

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/21/2007 11:30 AM	1250.0	1212.0		109.0	2.5			27.5	23.7						
3/21/2007 11:31 AM	1250.0	1213.0		109.0	2.2			27.5	23.5						
3/21/2007 11:32 AM	1250.0	1214.0		109.0	2.4			27.5	24.0						
3/21/2007 11:33 AM	1249.0	1214.0		109.0	2.2			27.5	23.6						
3/21/2007 11:34 AM	1250.0	1215.0		109.0	2.5			27.5	23.6						
3/21/2007 11:35 AM	1250.0	1215.0		109.0	2.3			27.5	23.6						
3/21/2007 11:36 AM	1250.0	1215.0		109.1	2.2			27.6	23.6						
3/21/2007 11:47 AM	1304.0	1180.0				151.0	19.4								Y
3/21/2007 12:09 PM	1609.0	1508.0	1820.0			153.0	19.1			26.0	1196.0	65.0	68.0	25.0	Y
3/21/2007 12:15 PM	1611.0	1500.0	1845.0			154.0	18.8			26.0	1195.0	64.0	68.0	24.8	Y
3/21/2007 12:30 PM	1610.0	1503.0	1887.0			152.0	18.6			26.0	1198.0	62.0	68.0	24.7	Y
3/21/2007 12:44 PM	1610.0	1496.0	1875.0			152.0	18.3			26.0	1195.0	60.0	68.0	24.0	Y
3/21/2007 12:59 PM	1610.0	1491.0	1879.0			152.0	18.1			26.0	1194.0	60.0	68.0	24.0	Y
3/21/2007 1:15 PM	1609.0	1491.0	1900.0			152.0	18.1			26.0	1194.0	60.0	69.0	23.6	Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp [°C]	TC10 Temp [°C]	Op Pyr Temp [°C]	Argon [slpm]	Argon Aux [slpm]	Hydrogen (H2) [slpm]	H2 Aux [slpm]	Acetylene [slpm]	Propylene [slpm]	MTS H2 Sweep [slpm]	MTS [g/hr]	Vaporizer Temp [°C]	Vaporizer Weight [Kg]	MTS Tank Weight [Kg]	Roto-Meters Turning
3/22 05:00															

TC7 = Furnace Control TC TC10 = Internal TC

Comments

Peak picker on Ircon turned on at 12:20 pm.
1:42 pm changed filters. 95 minutes into sic run

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	14.00	16.00
Front	16.00	15.00
Right Side	14.00	15.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data | Update | Cancel

Enable Form Signoff

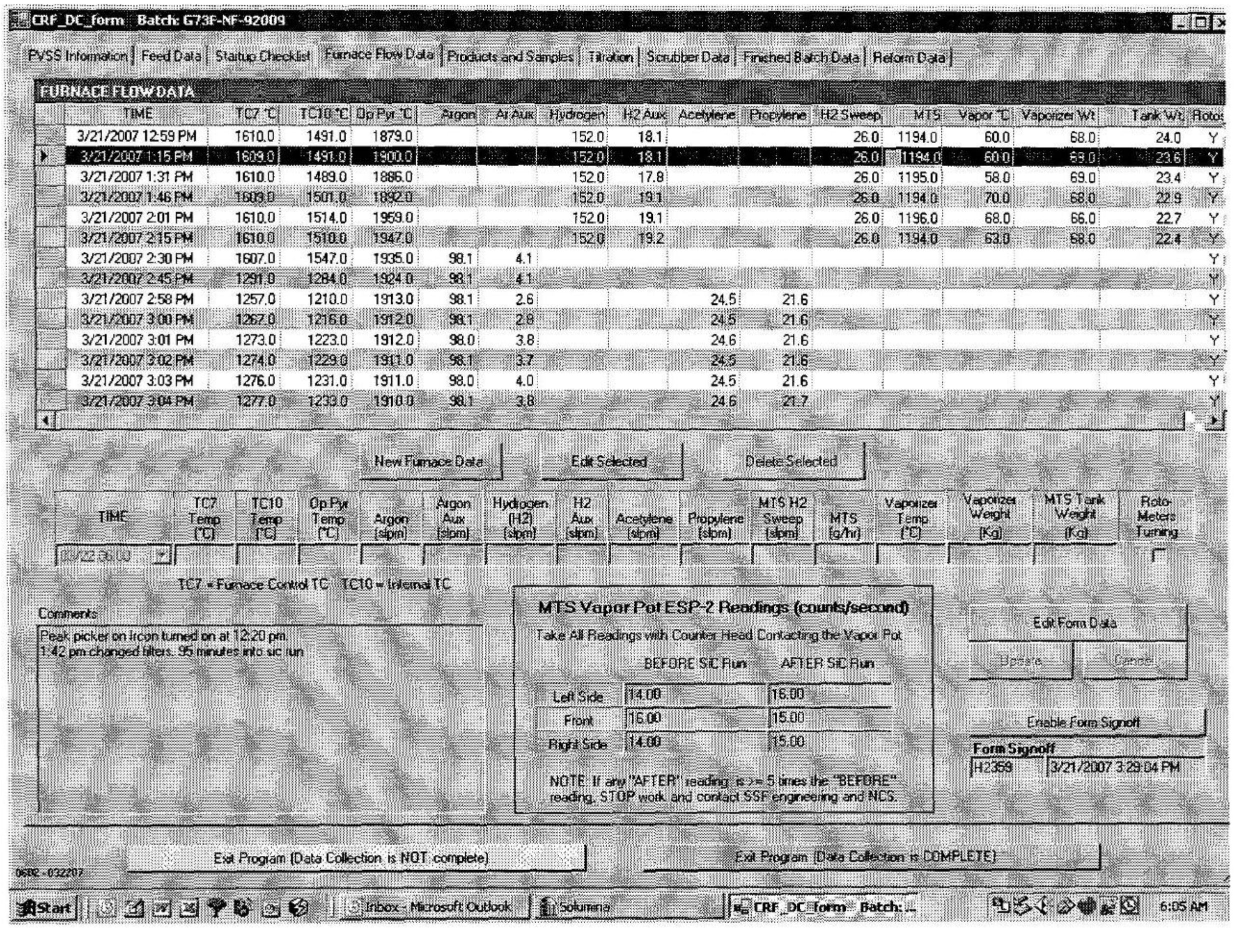
Form Signoff

H2359 3/21/2007 3:29:04 PM

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

0602-032207

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch:... | 6:01 AM



CRF_DC_form Batch: G73F-NF-92009

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/21/2007 12:59 PM	1610.0	1491.0	1879.0			152.0	18.1			26.0	1194.0	60.0	68.0	24.0	Y
3/21/2007 1:15 PM	1609.0	1491.0	1900.0			152.0	18.1			26.0	1194.0	60.0	69.0	23.6	Y
3/21/2007 1:31 PM	1610.0	1489.0	1886.0			152.0	17.8			26.0	1195.0	58.0	69.0	23.4	Y
3/21/2007 1:46 PM	1609.0	1501.0	1892.0			152.0	19.1			26.0	1194.0	70.0	68.0	22.9	Y
3/21/2007 2:01 PM	1610.0	1514.0	1959.0			152.0	19.1			26.0	1196.0	68.0	66.0	22.7	Y
3/21/2007 2:15 PM	1610.0	1510.0	1947.0			152.0	19.2			26.0	1194.0	63.0	68.0	22.4	Y
3/21/2007 2:30 PM	1607.0	1547.0	1935.0	98.1	4.1										Y
3/21/2007 2:45 PM	1291.0	1284.0	1924.0	98.1	4.1										Y
3/21/2007 2:58 PM	1257.0	1210.0	1913.0	98.1	2.6			24.5	21.6						Y
3/21/2007 3:00 PM	1267.0	1216.0	1912.0	98.1	2.8			24.5	21.6						Y
3/21/2007 3:01 PM	1273.0	1223.0	1912.0	98.0	3.8			24.6	21.6						Y
3/21/2007 3:02 PM	1274.0	1229.0	1911.0	98.1	3.7			24.5	21.6						Y
3/21/2007 3:03 PM	1276.0	1231.0	1911.0	98.0	4.0			24.5	21.6						Y
3/21/2007 3:04 PM	1277.0	1233.0	1910.0	98.1	3.8			24.6	21.7						Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Turning
3/22 5:00															

TC7 = Furnace Control TC TC10 = Internal TC

Comments

Peak picker on ircon turned on at 12:20 pm.
1:42 pm changed filters. 95 minutes into sic run

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	14.00	16.00
Front	16.00	15.00
Right Side	14.00	15.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

Edit Form Data | Update | Cancel

Enable Form Signoff

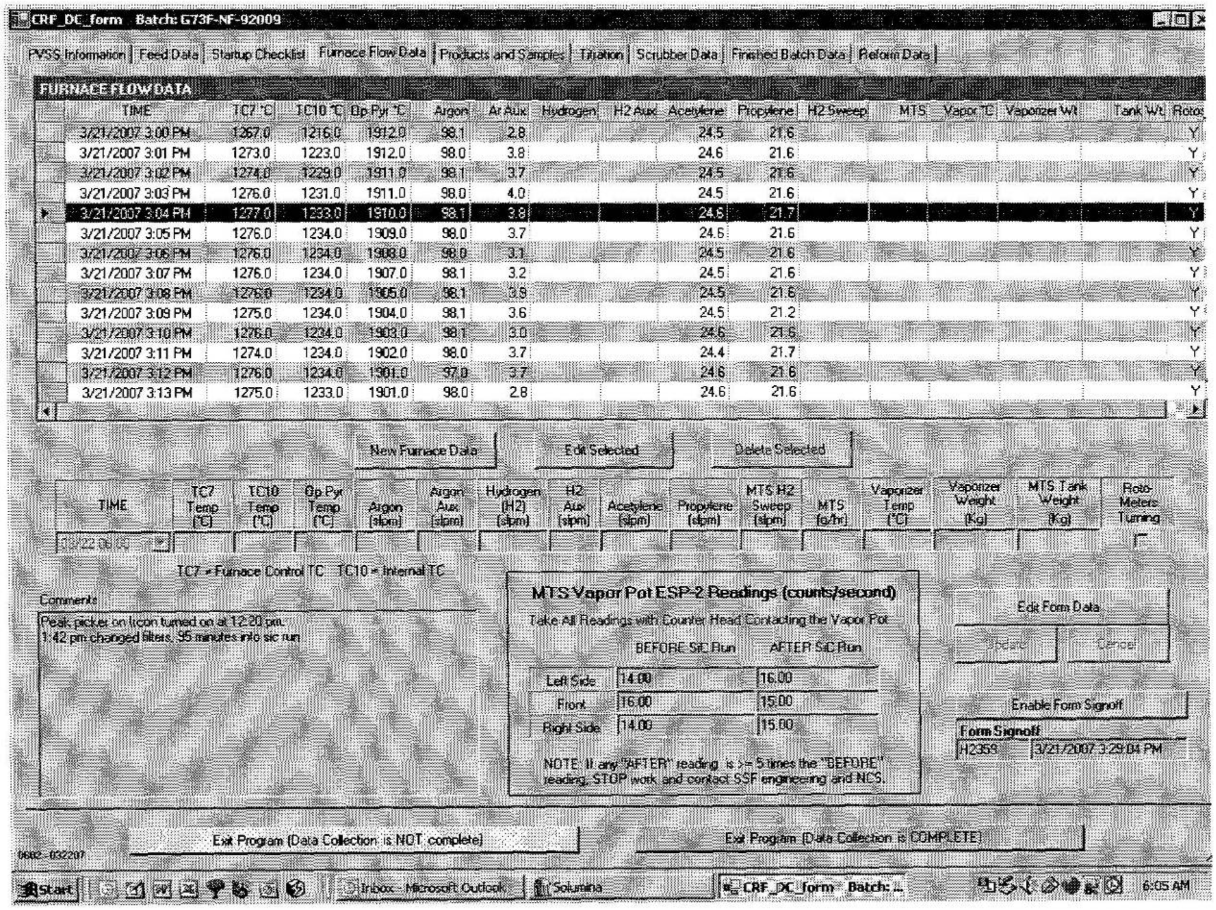
Form Signoff

H2359 | 3/21/2007 3:29:04 PM

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)

0602-032207

Start | Inbox - Microsoft Outlook | Solumina | CRF_DC_form Batch: ... | 6:05 AM



CRF_DC_form Batch: G73F-NF-92009

PVSS Information | Feed Data | Startup Checklist | Furnace Flow Data | Products and Samples | Titration | Scrubber Data | Finished Batch Data | Reform Data

FURNACE FLOW DATA

TIME	TC7 °C	TC10 °C	Op Pyr °C	Argon	Ar Aux	Hydrogen	H2 Aux	Acetylene	Propylene	H2 Sweep	MTS	Vapor °C	Vaporizer Wt	Tank Wt	Rotos
3/21/2007 3:00 PM	1267.0	1216.0	1912.0	98.1	2.8			24.5	21.6						Y
3/21/2007 3:01 PM	1273.0	1223.0	1912.0	98.0	3.8			24.6	21.6						Y
3/21/2007 3:02 PM	1274.0	1229.0	1911.0	98.1	3.7			24.5	21.6						Y
3/21/2007 3:03 PM	1276.0	1231.0	1911.0	98.0	4.0			24.5	21.6						Y
3/21/2007 3:04 PM	1277.0	1233.0	1910.0	98.1	3.8			24.6	21.7						Y
3/21/2007 3:05 PM	1276.0	1234.0	1909.0	98.0	3.7			24.6	21.6						Y
3/21/2007 3:06 PM	1276.0	1234.0	1908.0	98.0	3.1			24.5	21.6						Y
3/21/2007 3:07 PM	1276.0	1234.0	1907.0	98.1	3.2			24.5	21.6						Y
3/21/2007 3:08 PM	1276.0	1234.0	1905.0	98.1	3.9			24.5	21.6						Y
3/21/2007 3:09 PM	1275.0	1234.0	1904.0	98.1	3.6			24.5	21.2						Y
3/21/2007 3:10 PM	1276.0	1234.0	1903.0	98.1	3.0			24.6	21.6						Y
3/21/2007 3:11 PM	1274.0	1234.0	1902.0	98.0	3.7			24.4	21.7						Y
3/21/2007 3:12 PM	1276.0	1234.0	1901.0	97.0	3.7			24.6	21.6						Y
3/21/2007 3:13 PM	1275.0	1233.0	1901.0	98.0	2.8			24.6	21.6						Y

New Furnace Data | Edit Selected | Delete Selected

TIME	TC7 Temp (°C)	TC10 Temp (°C)	Op Pyr Temp (°C)	Argon (slpm)	Argon Aux (slpm)	Hydrogen (H2) (slpm)	H2 Aux (slpm)	Acetylene (slpm)	Propylene (slpm)	MTS H2 Sweep (slpm)	MTS (g/hr)	Vaporizer Temp (°C)	Vaporizer Weight (Kg)	MTS Tank Weight (Kg)	Roto-Meters Turning
03/22 06:05															

TC7 = Furnace Control TC TC10 = Internal TC

Comments

Peak picker on Icon turned on at 12:20 pm.
1:42 pm changed filters, 35 minutes into sic run

MTS Vapor Pot ESP-2 Readings (counts/second)

Take All Readings with Counter Head Contacting the Vapor Pot

	BEFORE SiC Run	AFTER SiC Run
Left Side	14.00	16.00
Front	16.00	15.00
Right Side	14.00	15.00

NOTE: If any "AFTER" reading is >= 5 times the "BEFORE" reading, STOP work and contact SSF engineering and NCS.

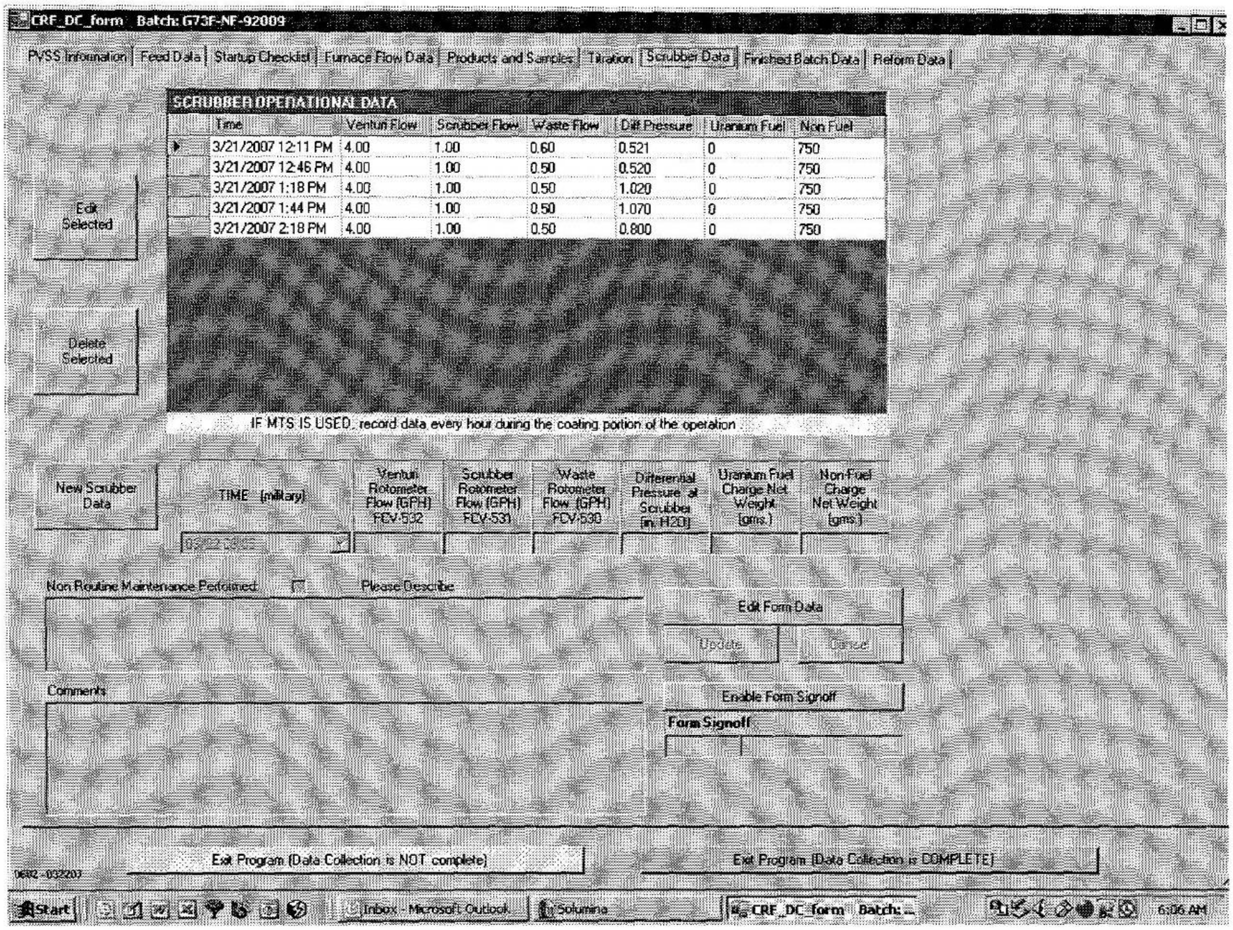
Edit Form Data | Update | Cancel

Enable Form Signoff

Form Signoff

H2359 3/21/2007 3:29:04 PM

Exit Program (Data Collection is NOT complete) | Exit Program (Data Collection is COMPLETE)


CRF_DC_form Batch: G73F-NF-92009
PVSS Information
Feed Data
Startup Checklist
Furnace Flow Data
Products and Samples
Titration
Scrubber Data
Finished Batch Data
Reform Data
SCRUBBER OPERATIONAL DATA
Time | Venturi Flow | Scrubber Flow | Waste Flow | Diff Pressure | Uranium Fuel | Non Fuel
3/21/2007 12:11 PM | 4.00 | 1.00 | 0.60 | 0.521 | 0 | 750
3/21/2007 12:46 PM | 4.00 | 1.00 | 0.50 | 0.520 | 0 | 750
3/21/2007 1:18 PM | 4.00 | 1.00 | 0.50 | 1.020 | 0 | 750
3/21/2007 1:44 PM | 4.00 | 1.00 | 0.50 | 1.070 | 0 | 750
3/21/2007 2:18 PM | 4.00 | 1.00 | 0.50 | 0.800 | 0 | 750
Edit Selected
Delete Selected
IF MTS IS USED, record data every hour during the coating portion of the operation
New Scrubber Data
TIME (military)
Venturi Rotometer Flow (GPH) FCV-532
Scrubber Rotometer Flow (GPH) FCV-531
Waste Rotometer Flow (GPH) FCV-530
Differential Pressure at Scrubber (in. H2O)
Uranium Fuel Charge Net Weight (gms.)
Non-Fuel Charge Net Weight (gms.)
Non Routine Maintenance Performed:
Please Describe
Edit Form Data
Update
Cancel
Comments
Enable Form Signoff
Form Signoff
Exit Program (Data Collection is NOT complete)
Exit Program (Data Collection is COMPLETE)
Start
Inbox - Microsoft Outlook
Solumina
CRF_DC_form Batch:
6:06 AM

Batch 92009 Particle Photos