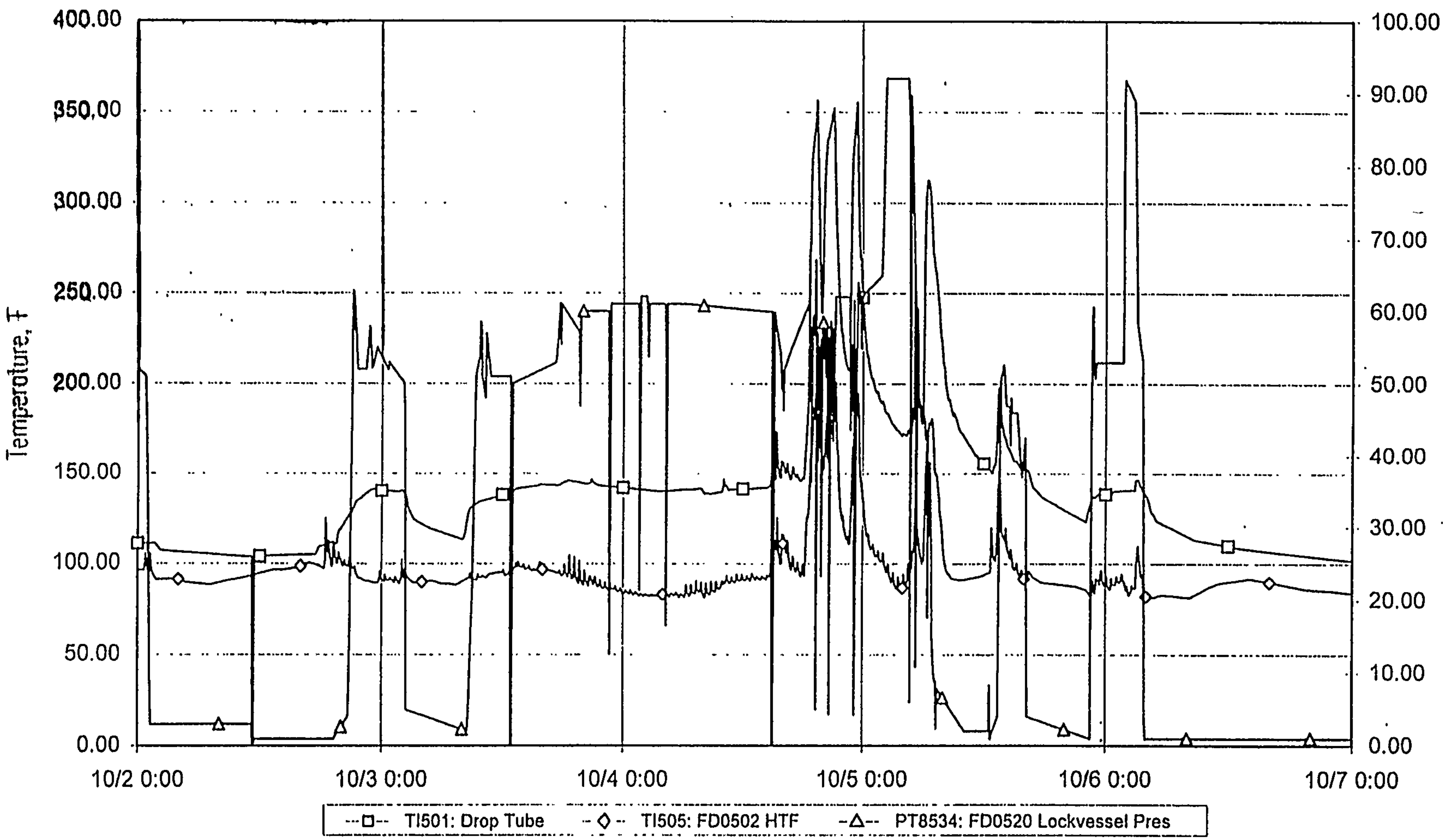


DOE Plot 18 of 45 - 5 minute data

Figure 5.1.8-18 PCD Ash Temperatures for October 2 through October 6, 1996

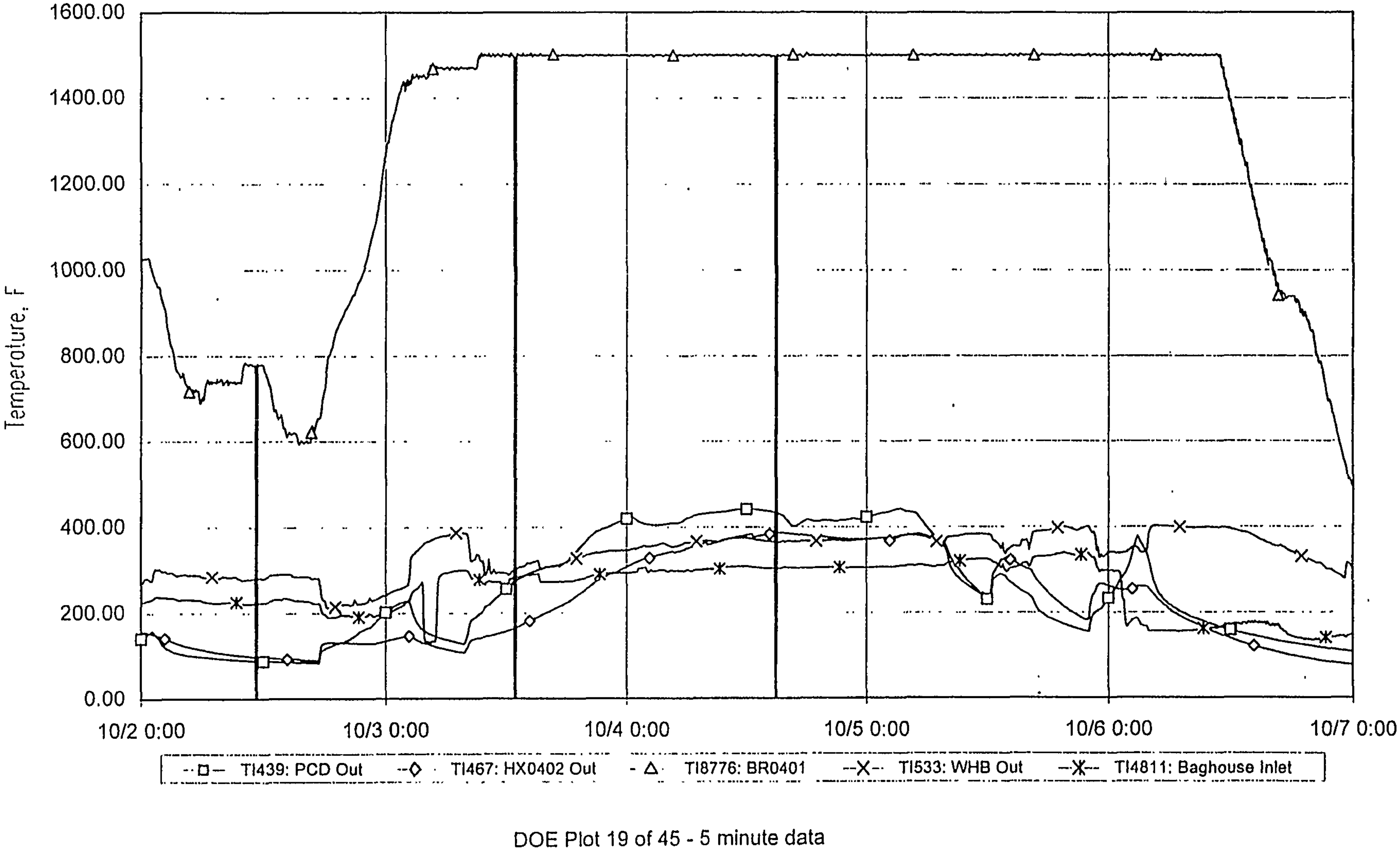
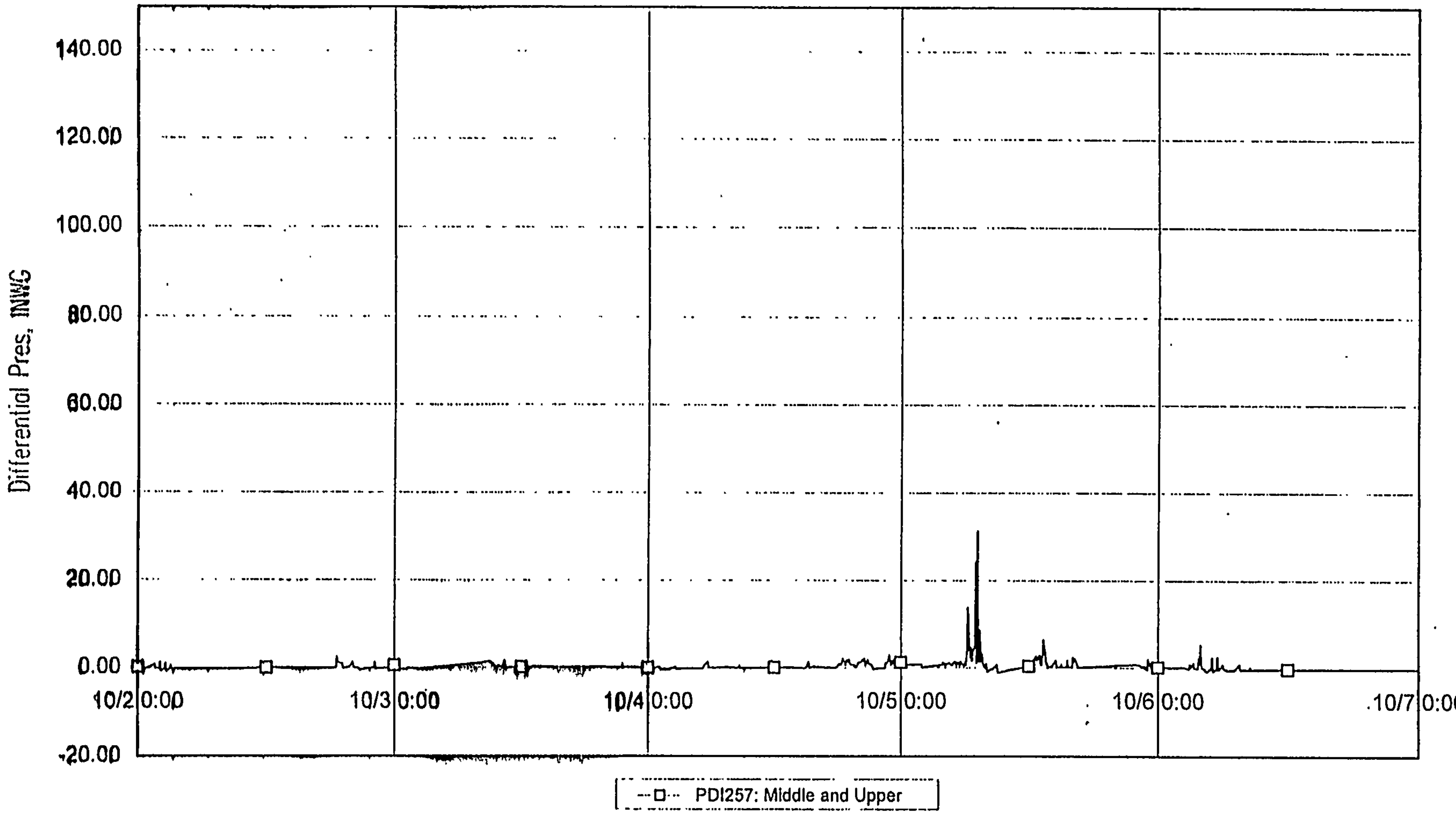
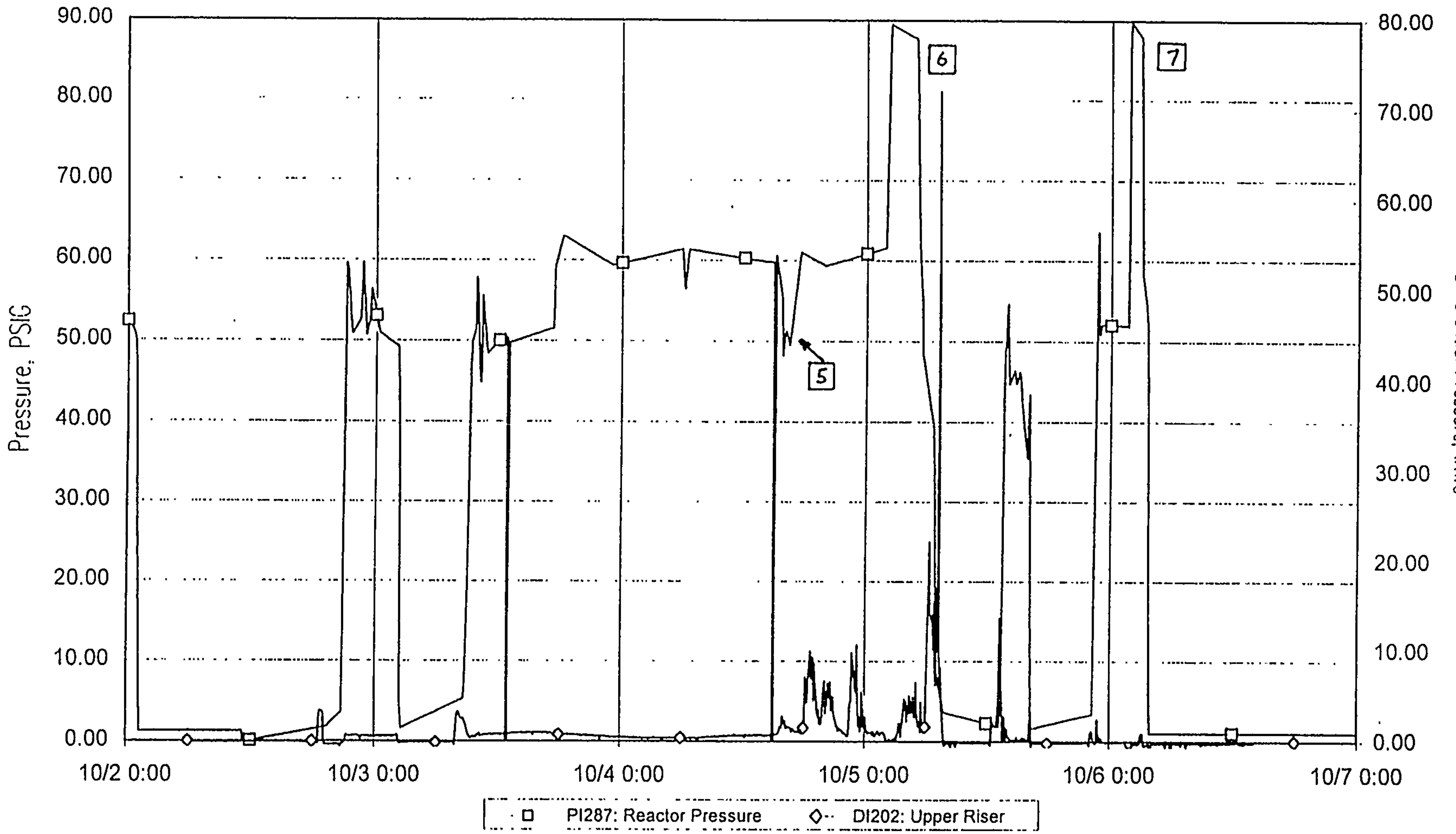


Figure 5.1.8-19 System Temperatures Downstream of PCD for October 2 through October 6, 1996



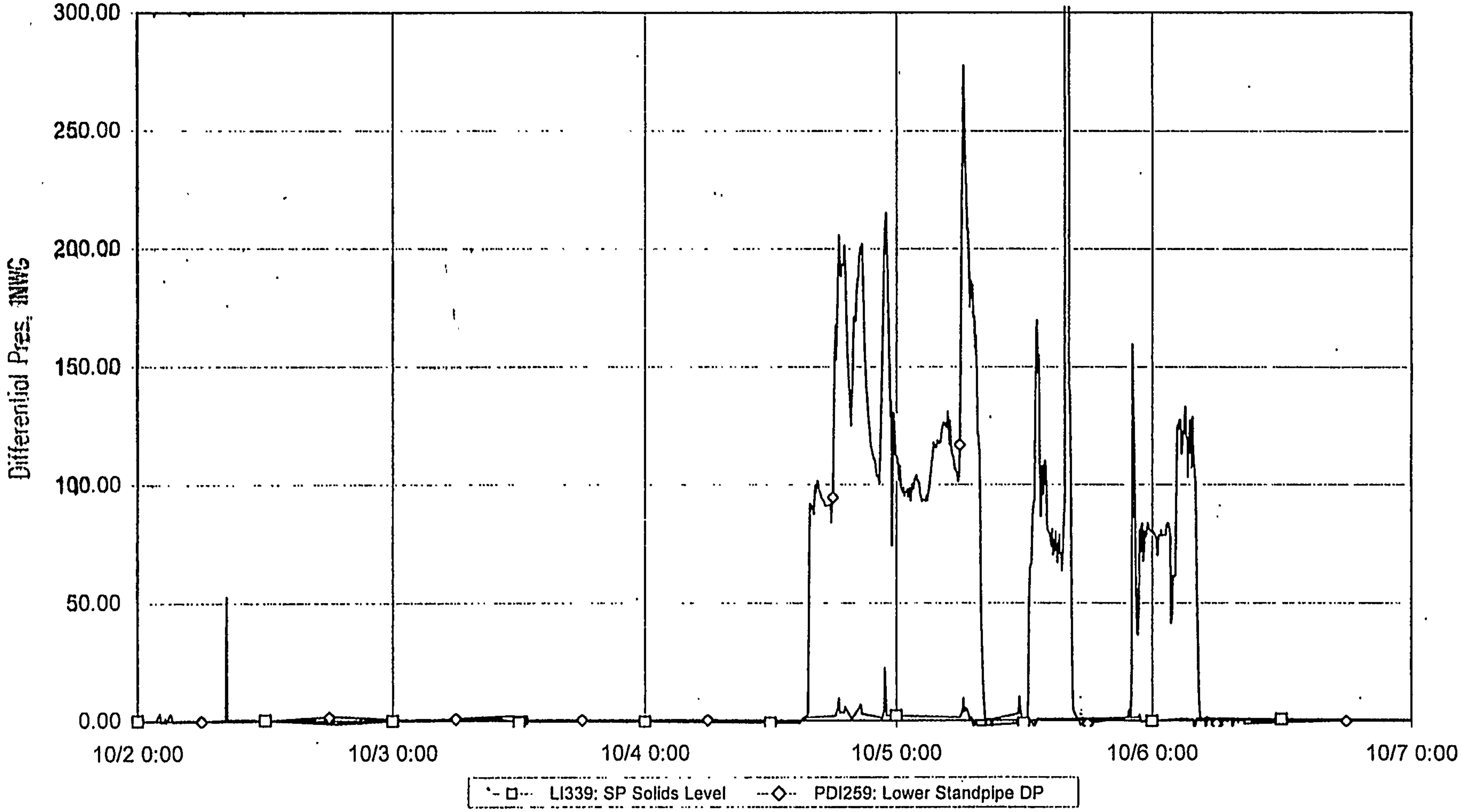
DOE Plot 20 of 45 - 5 minute data

Figure 5.1.8-20 Mixing Zone DP Profile for October 2 through October 6, 1996



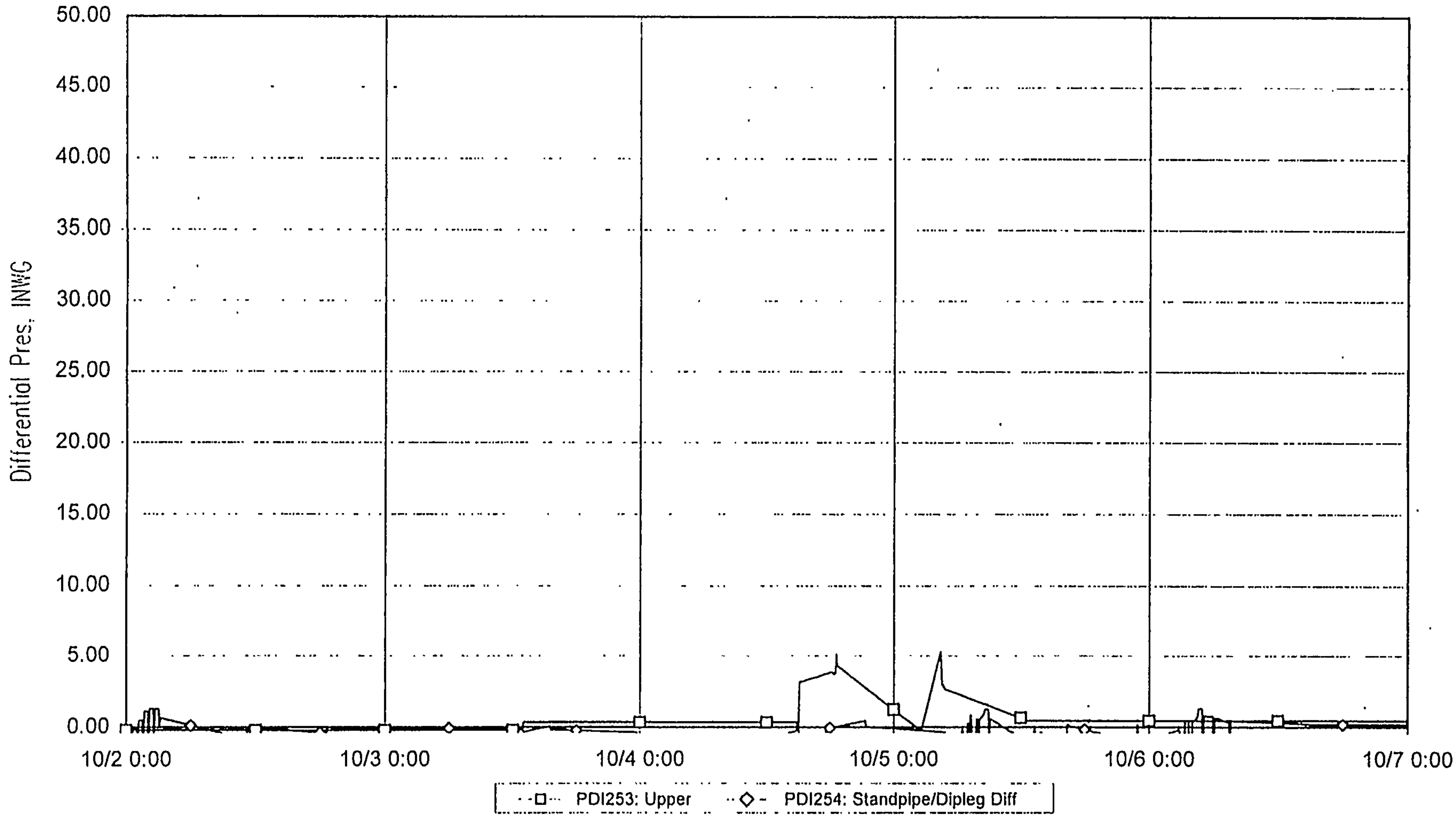
DOE Plot 21 of 45 - 5 minute data

Figure 5.1.8-21 Reactor Pressure/Riser DP Profiles for October 2 through October 6, 1996



DOE Plot 22 of 45 - 5 minute data

Figure 5.1.8-22 Standpipe DP Profiles for October 2 through October 6, 1996



DOE Plot 23 of 45 - 5 minute data

Figure 5.1.8-23 CY0201 Dipleg DP Profiles for October 2 through October 6, 1996

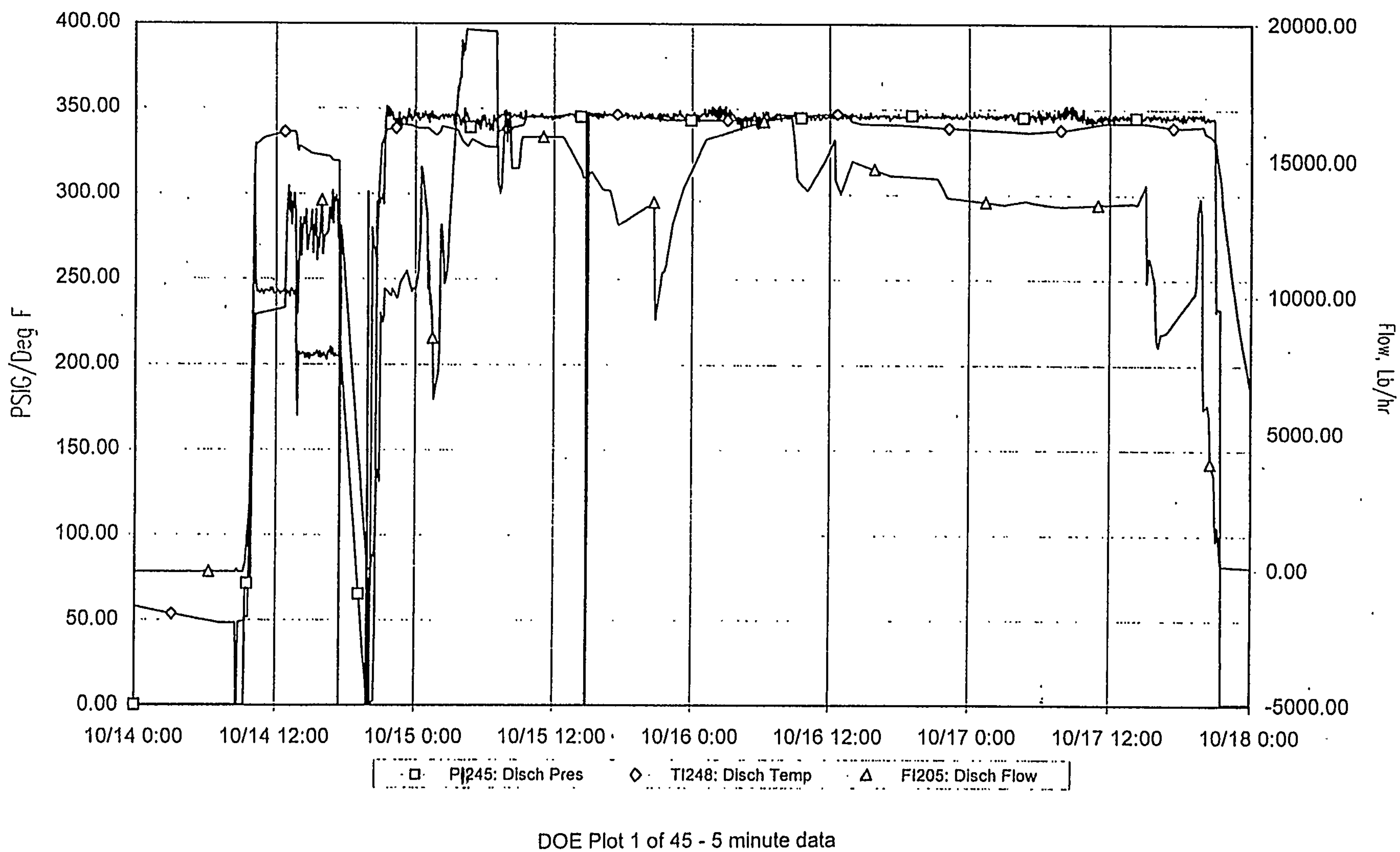
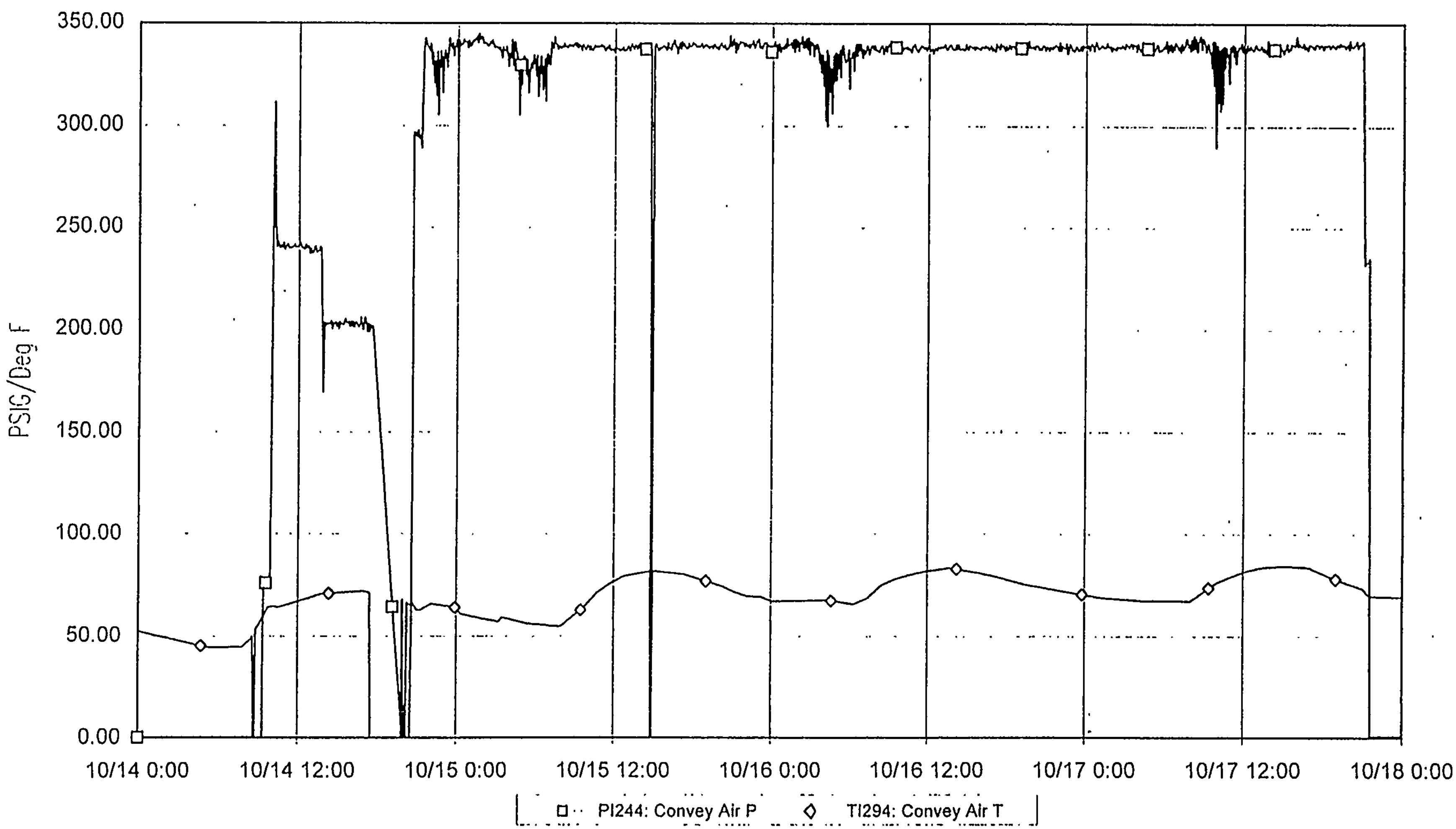
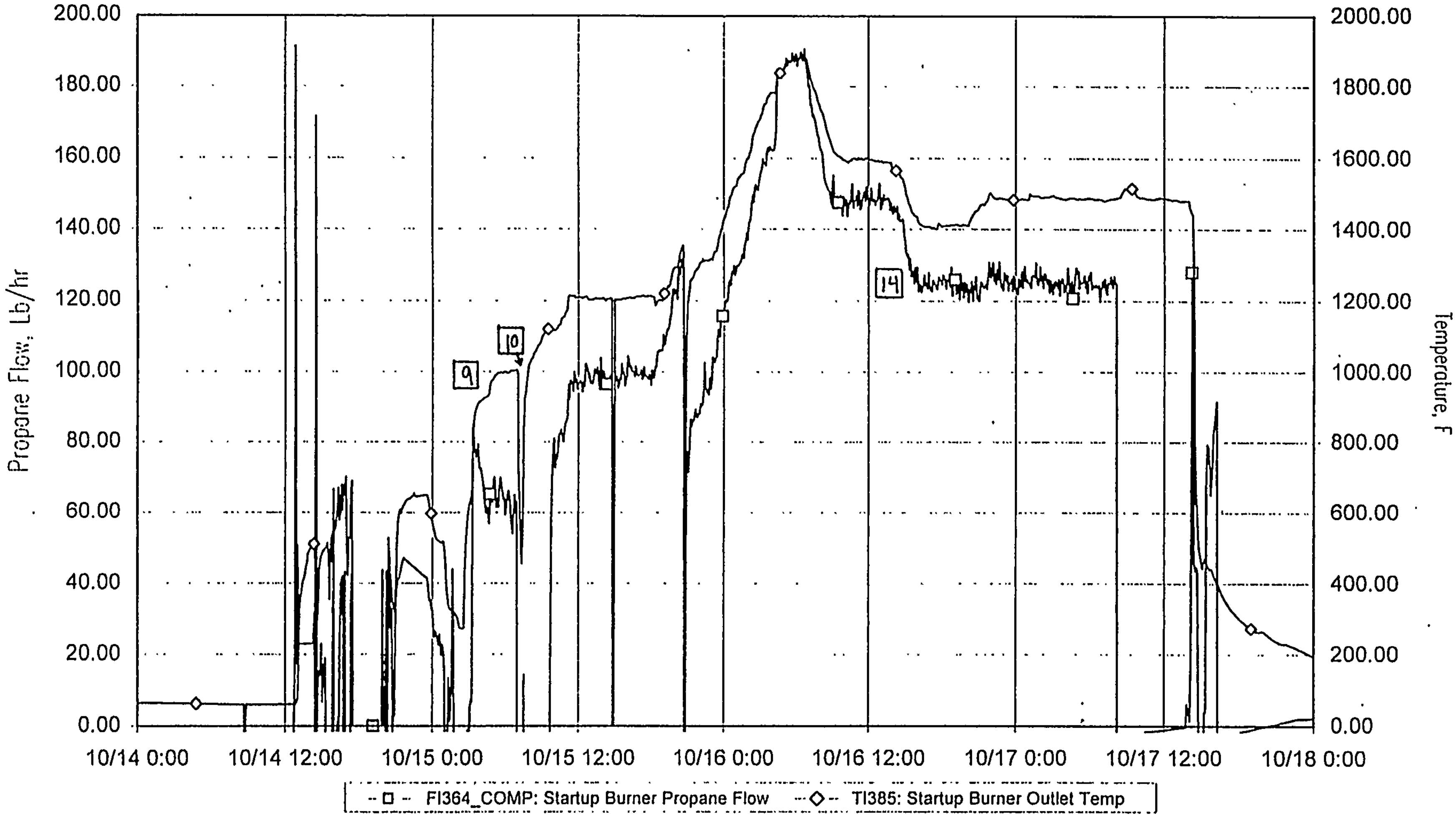


Figure 5.1.8-24 CO0201 System Profile for October 14 through October 17, 1996



DOE Plot 5 of 45 - 5 minute data

Figure 5.1.8-25 Transport Air System for October 14 through October 17, 1996



DOE Plot 11 of 45 - 5 minute data

Figure 5.1.8-26 Start-Up Burner Flow/Temperature for October 14 through October 17, 1996

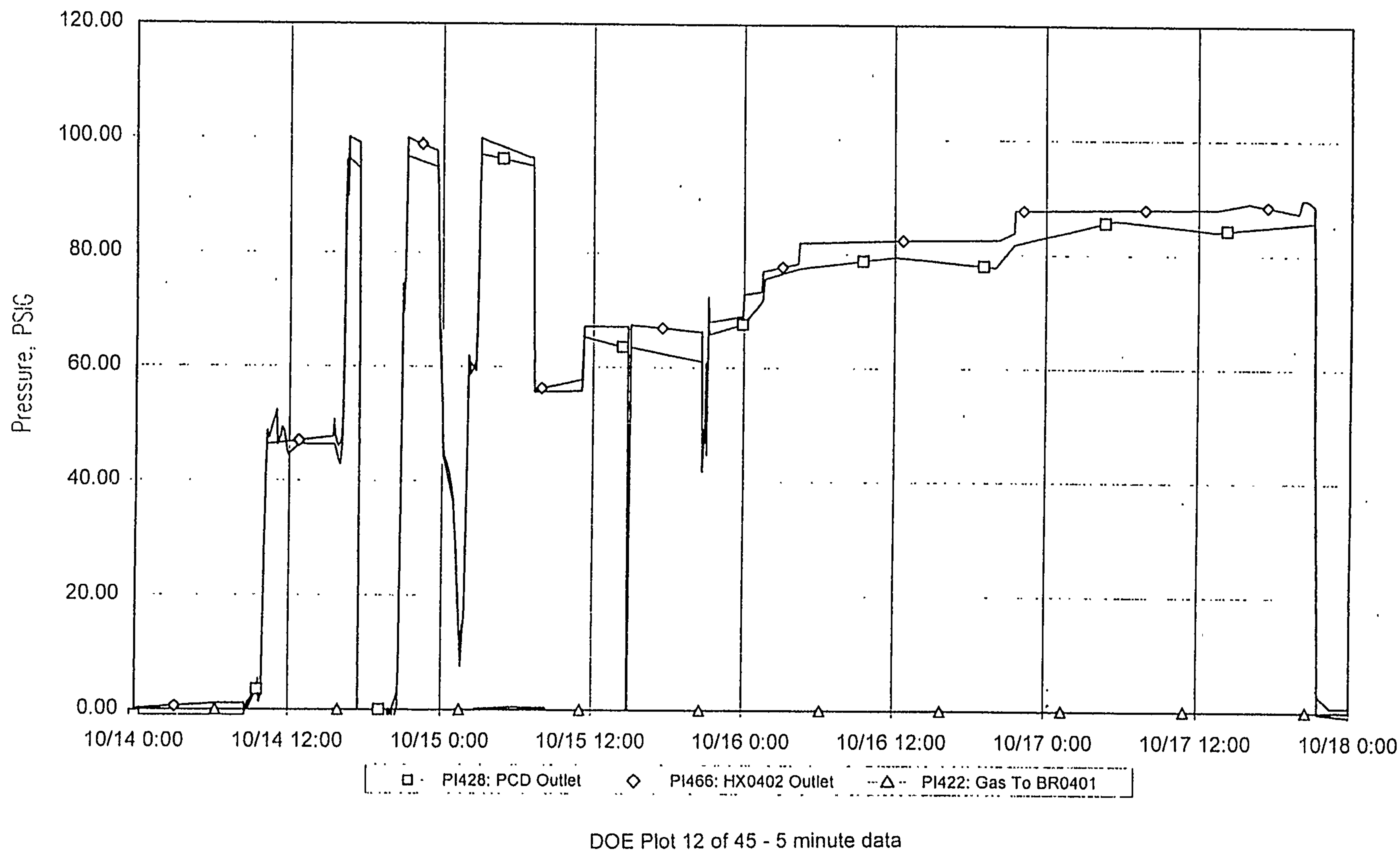
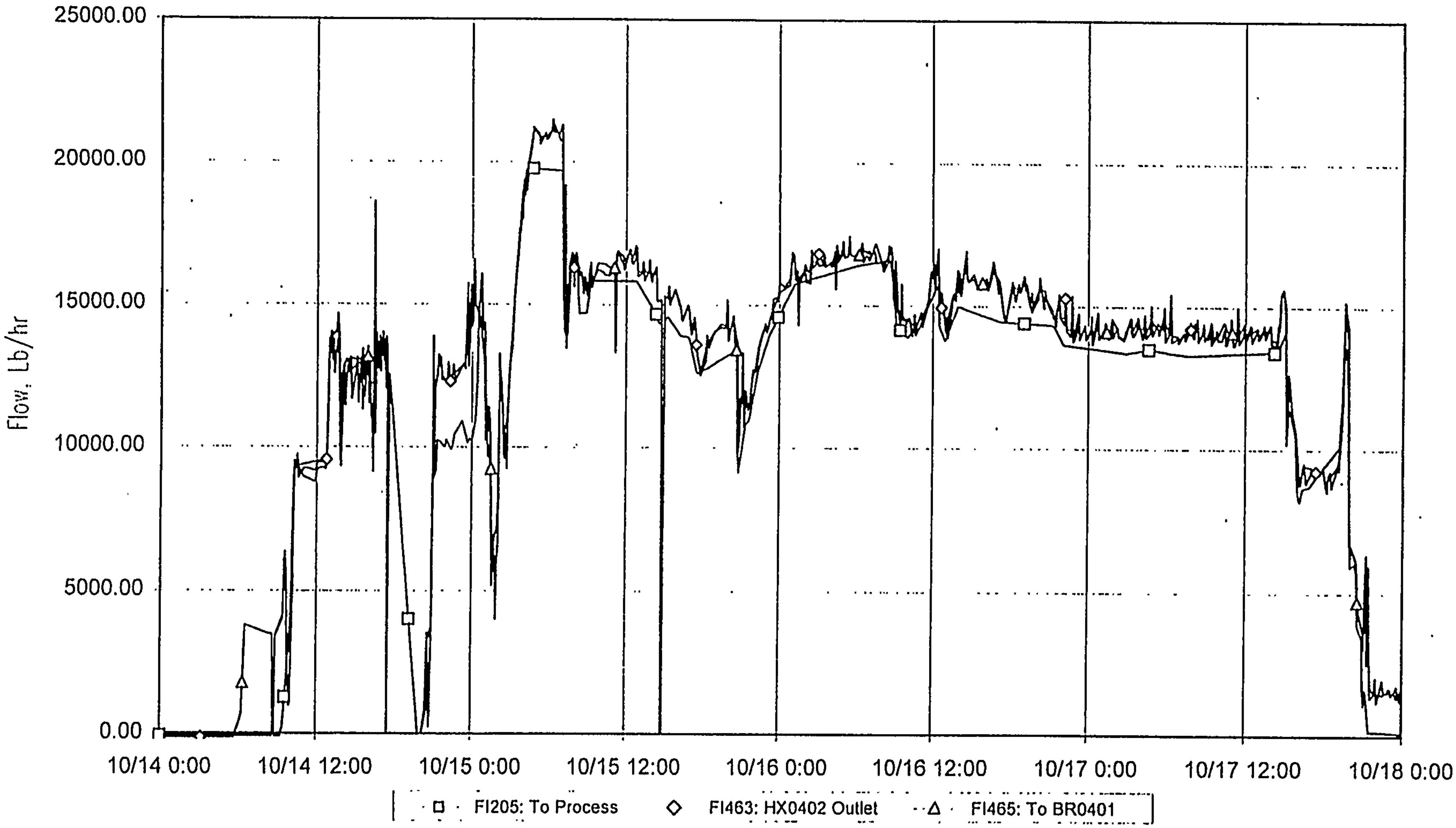
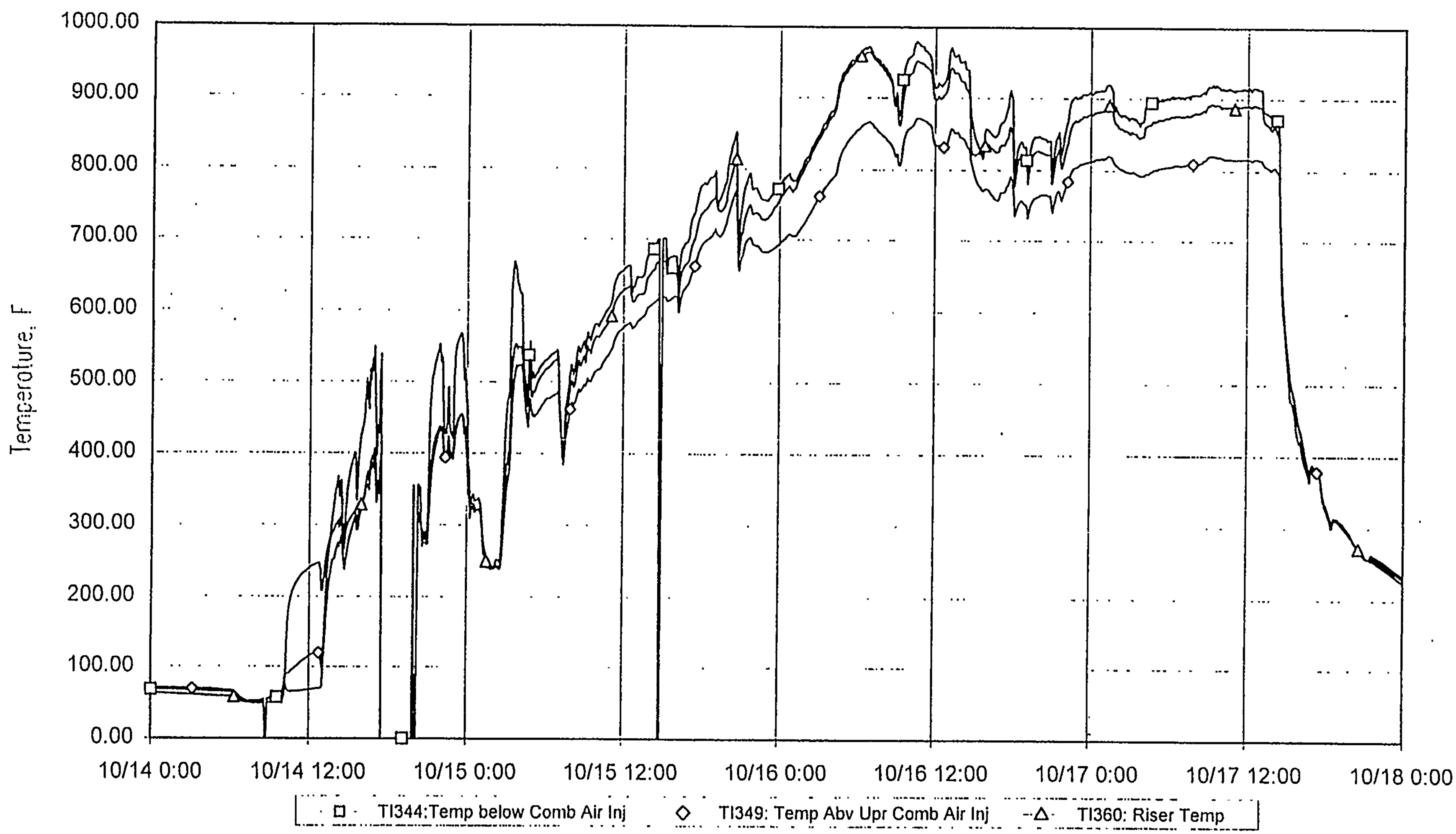


Figure 5.1.8-27 System Pressures Downstream of PCD for October 14 through October 17, 1996



DOE Plot 13 of 45 - 5 minute data

Figure 5.1.8-28 Total Gas In/Out Flow Rates for October 14 through October 17, 1996



DOE Plot 14 of 45 - 5 minute data

Figure 5.1.8-29 Reactor Mixing Zone and Riser Temperatures for October 14 through October 17, 1996

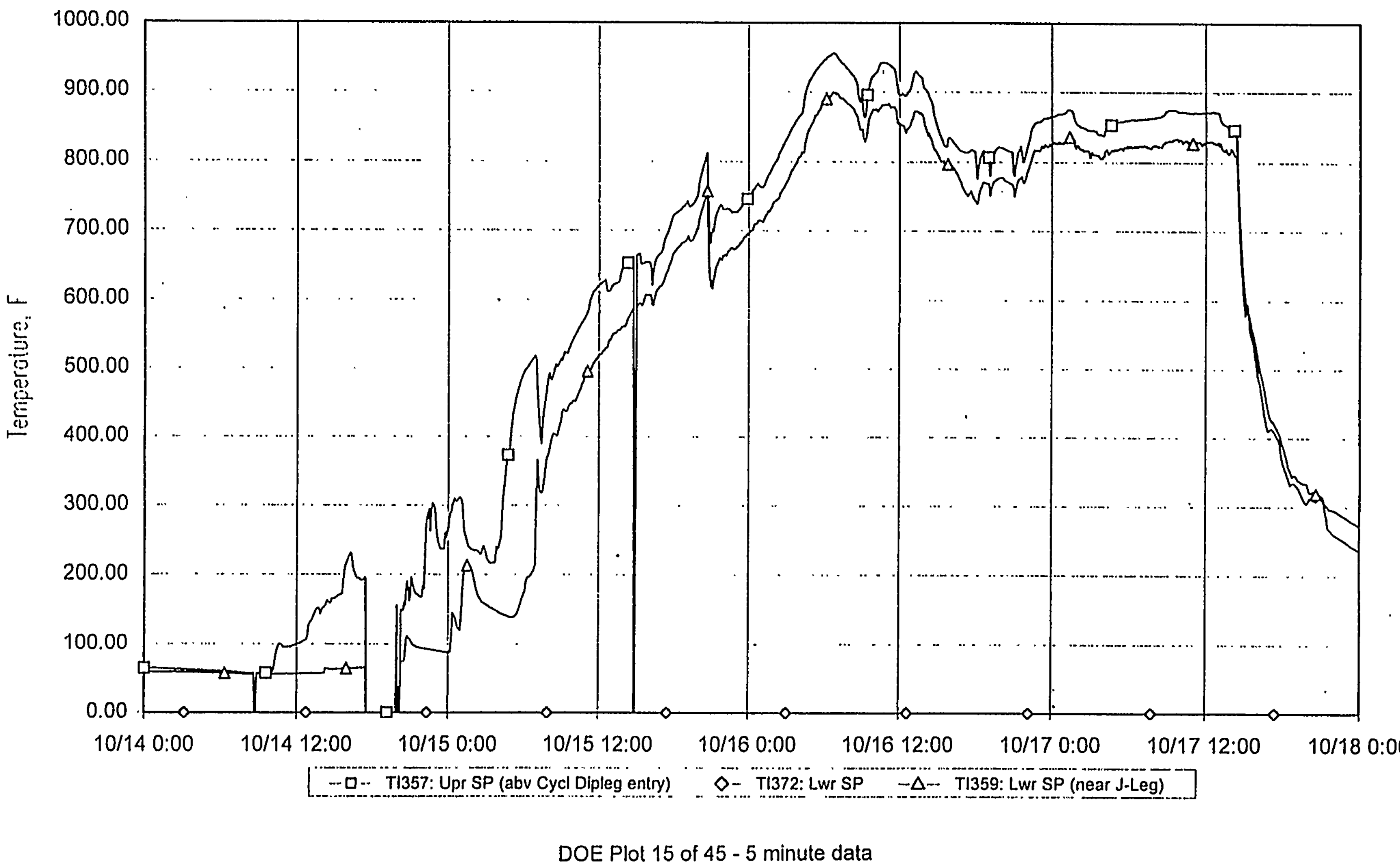


Figure 5.1.8-30 Standpipe Temperature for October 14 through October 17, 1996

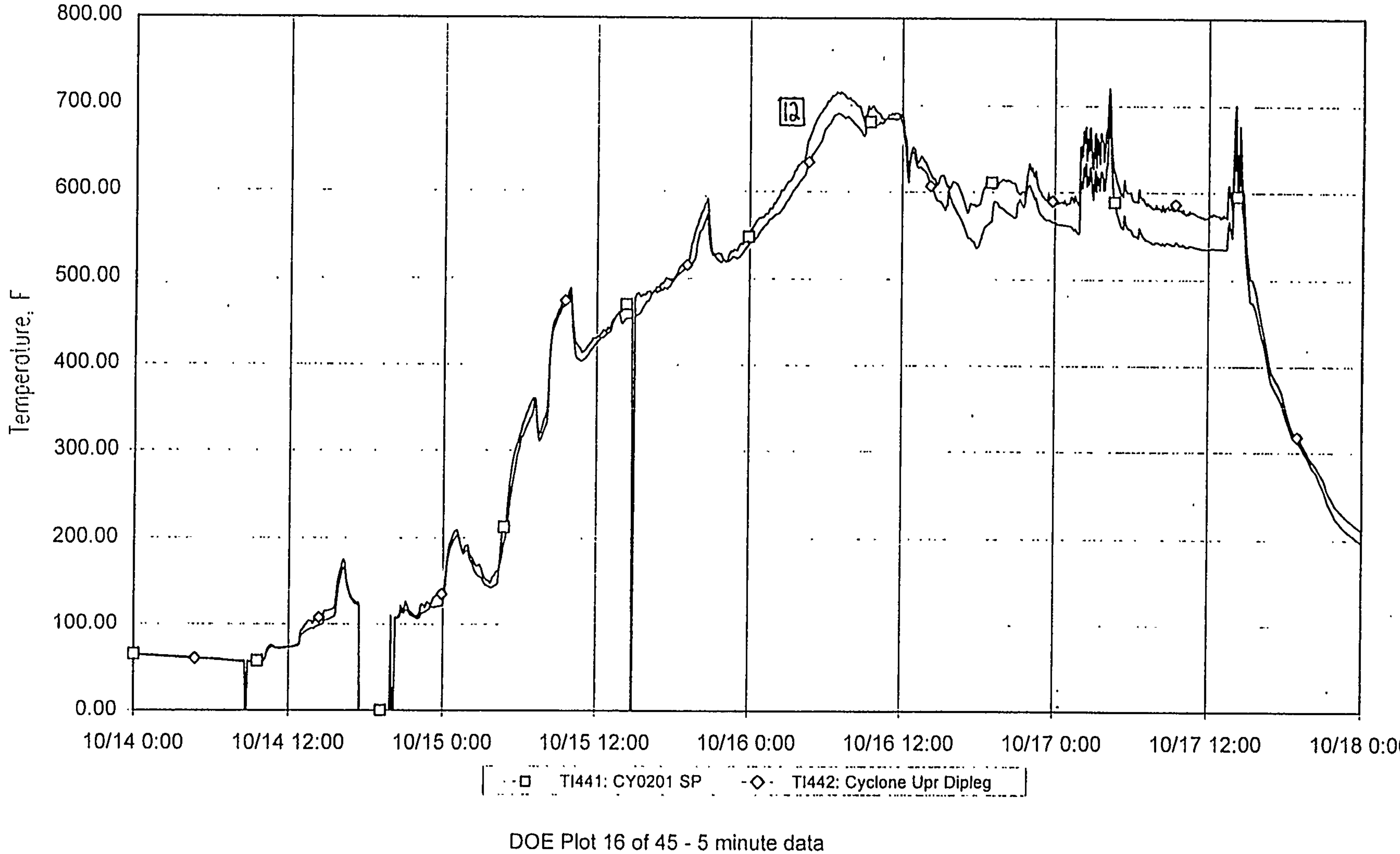
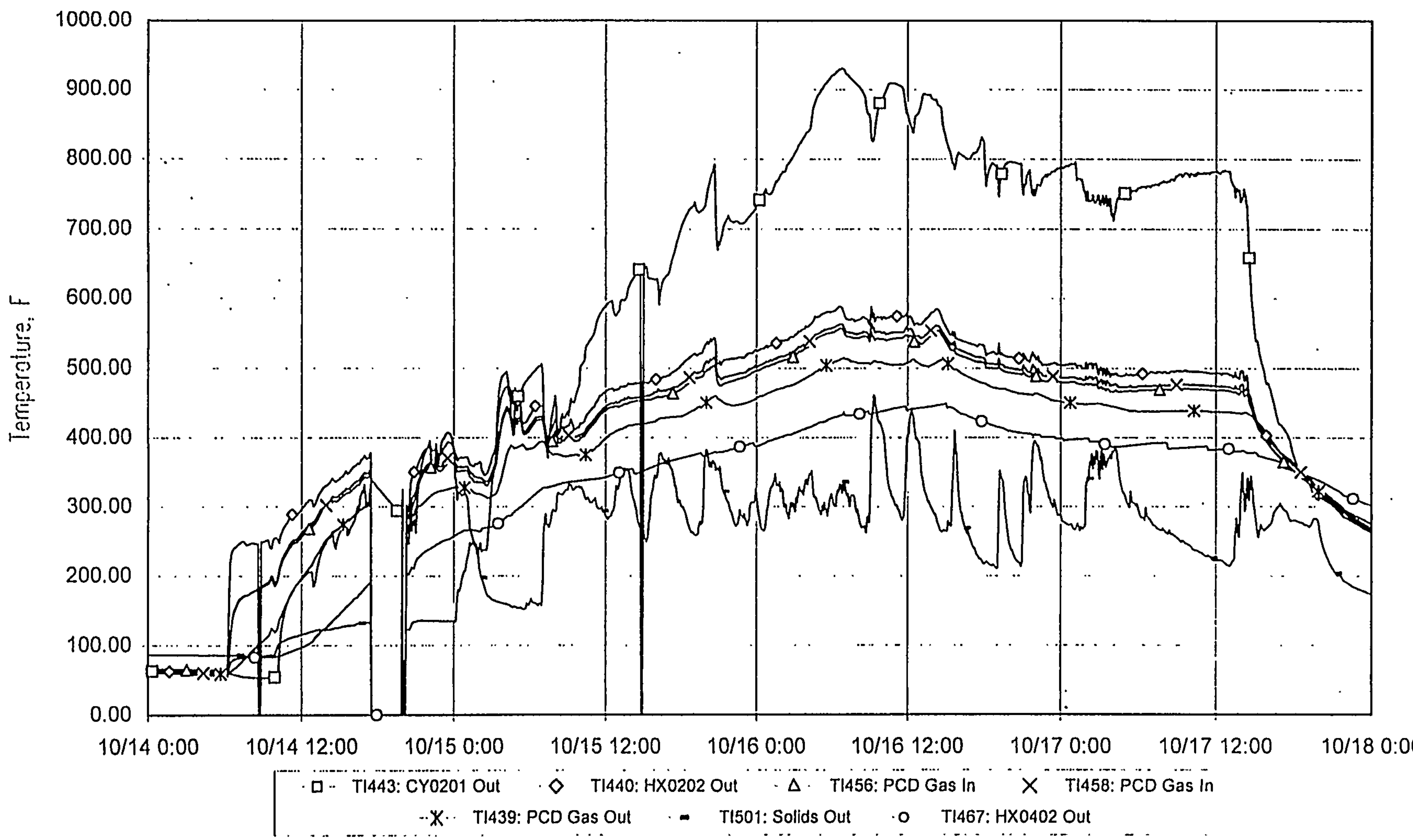
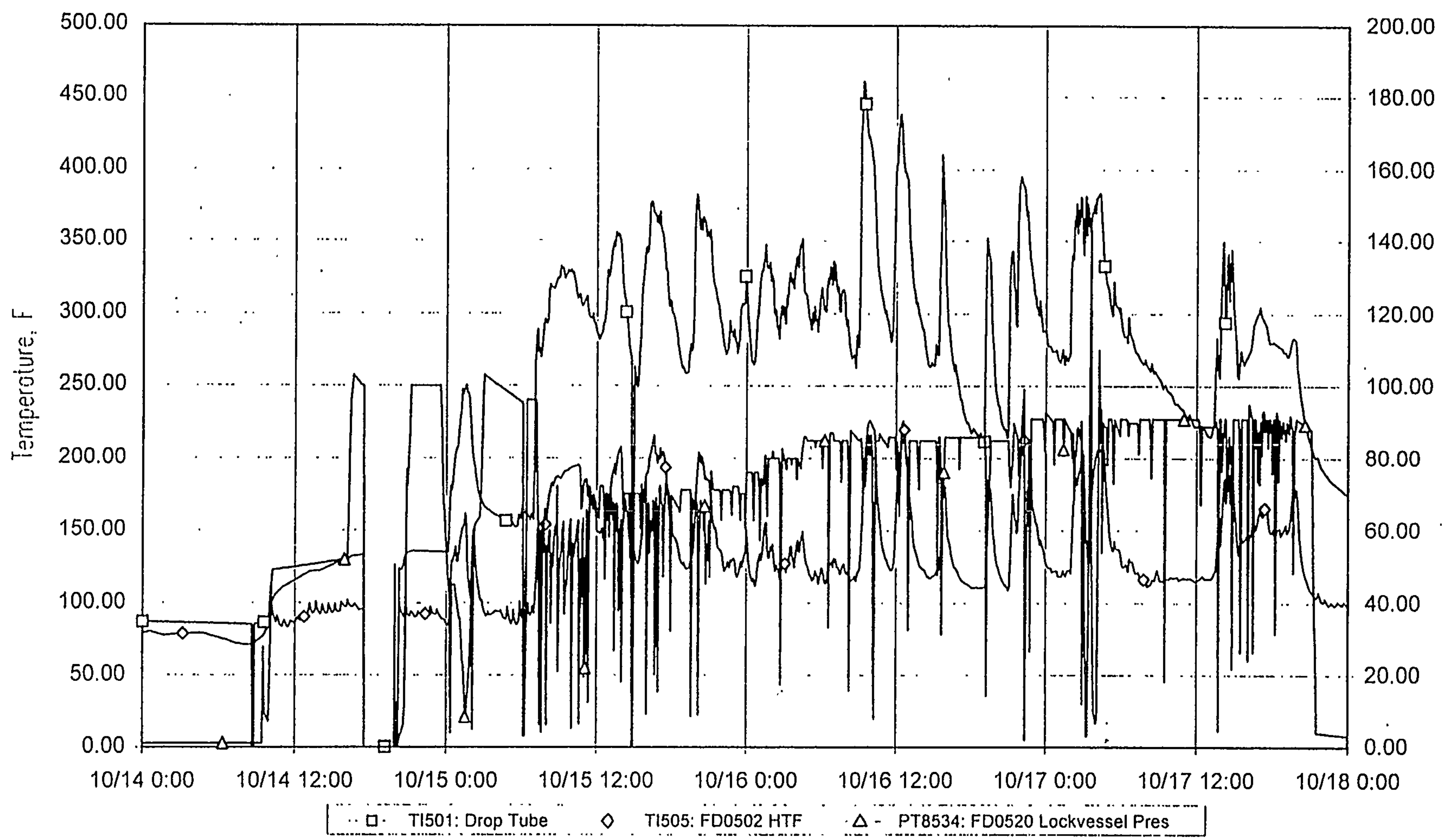


Figure 5.1.8-31 Cyclone Dipleg Temperature for October 14 through October 17, 1996



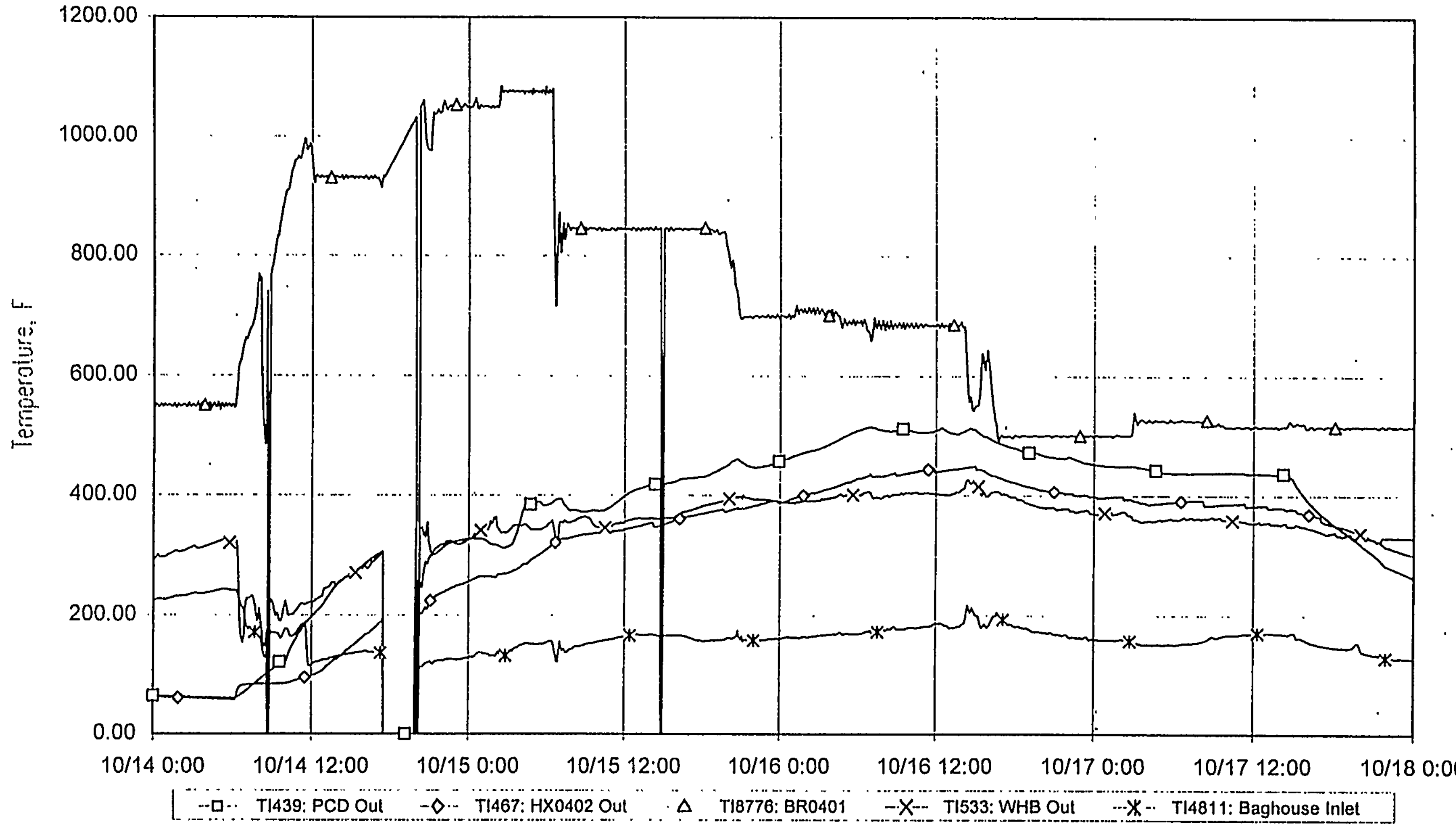
DOE Plot 17 of 45 - 5 minute data

Figure 5.1.8-32 Temperature Profiles Downstream of Reactor for October 14 through October 17, 1996



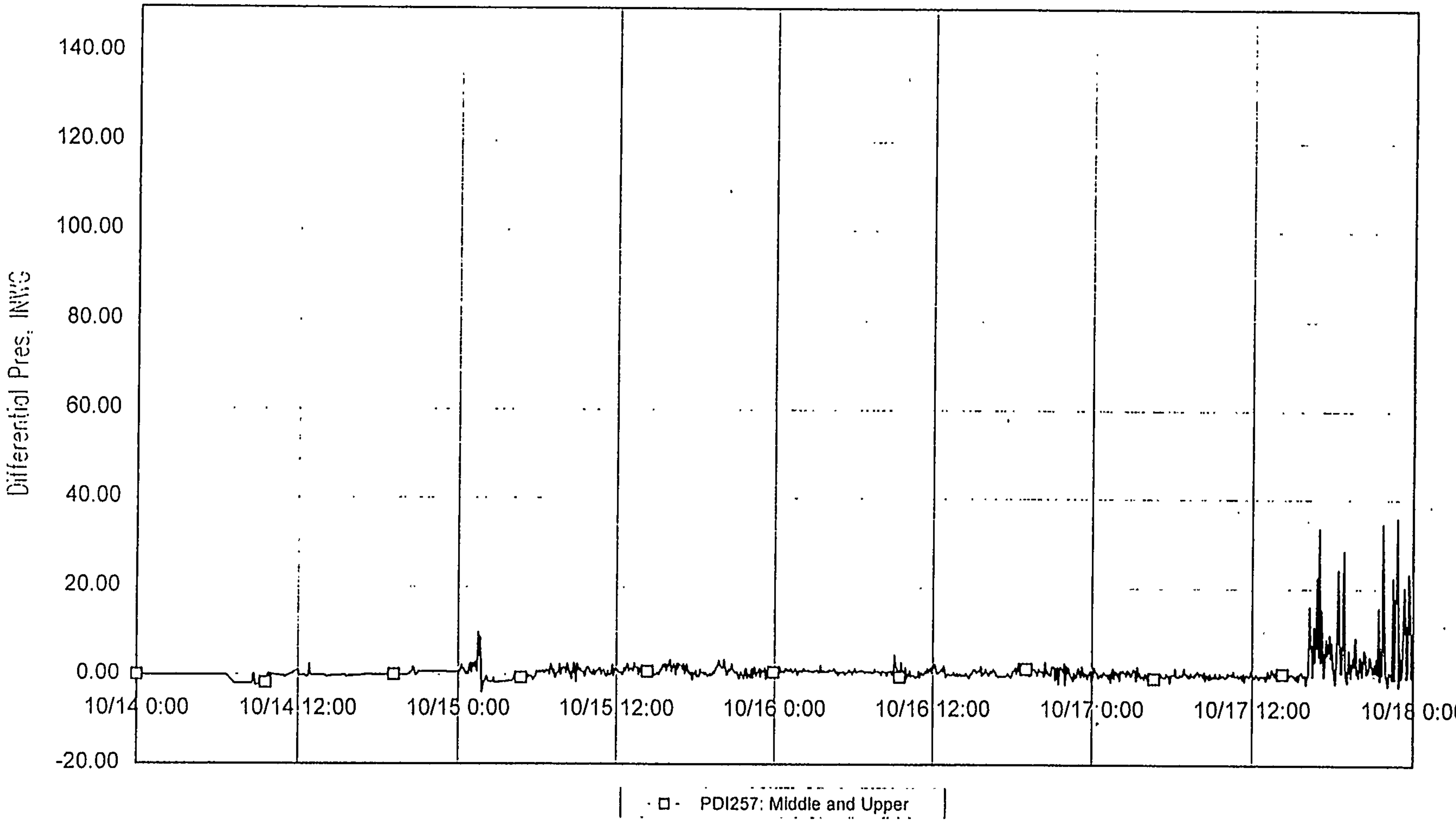
DOE Plot 18 of 45 - 5 minute data

Figure 5.1.8-33 PCD Ash Temperatures for October 14 through October 17, 1996



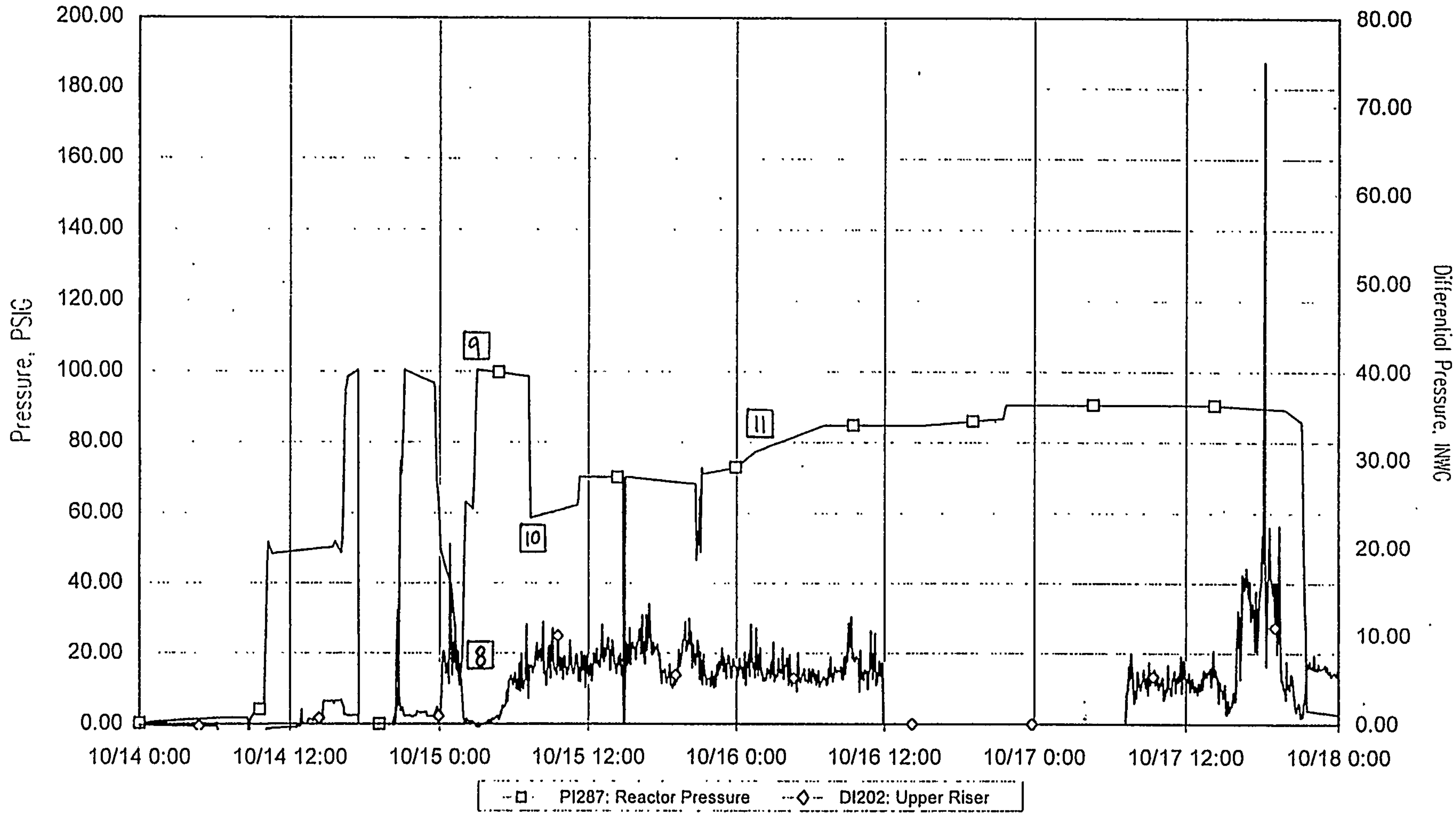
DOE Plot 19 of 45 - 5 minute data

Figure 5.1.8-34 System Temperatures Downstream of PCD for October 14 through October 17, 1996



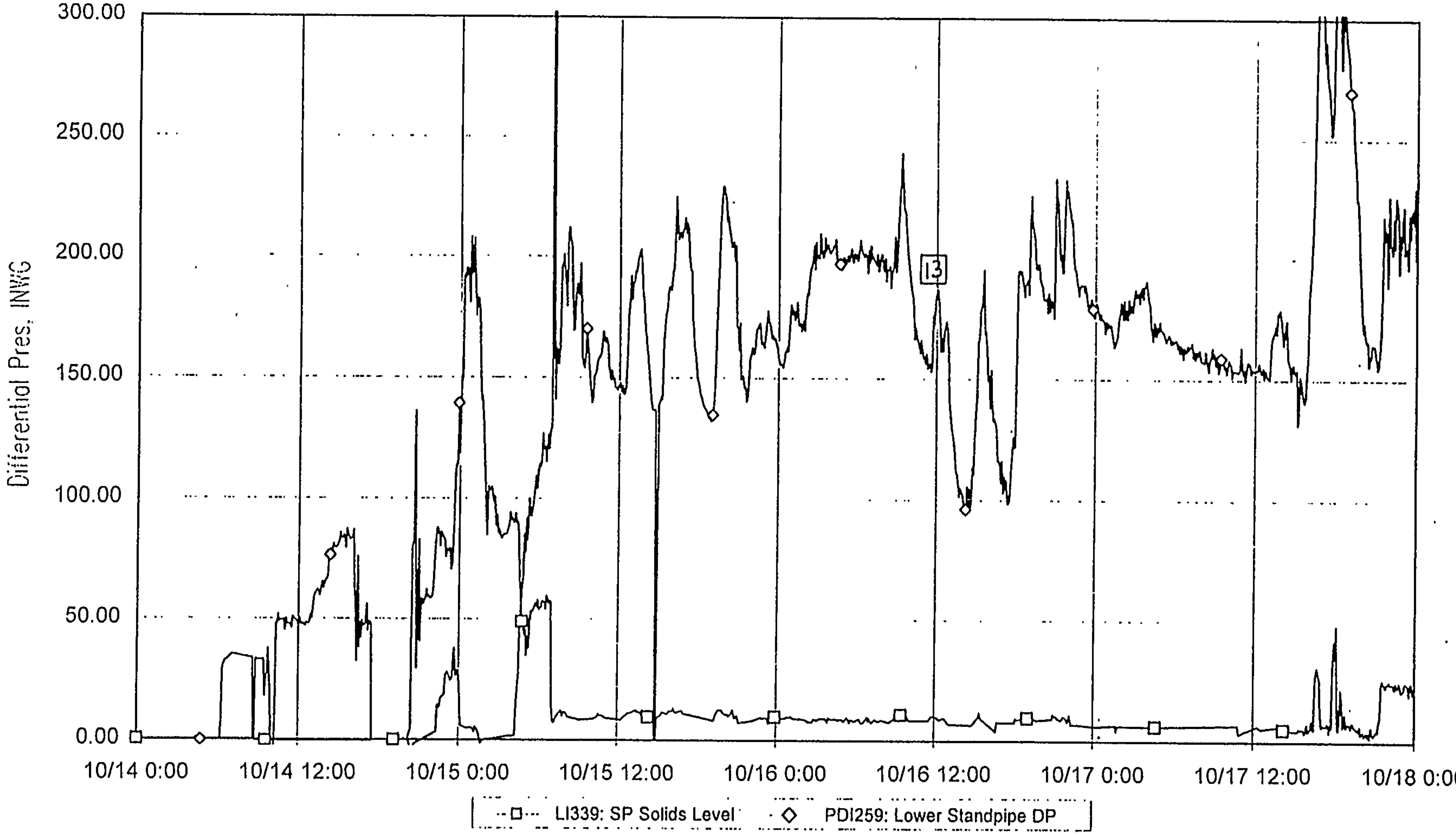
DOE Plot 20 of 45 - 5 minute data

Figure 5.1.8-35 Mixing Zone DP Profile for October 14 through October 17, 1996



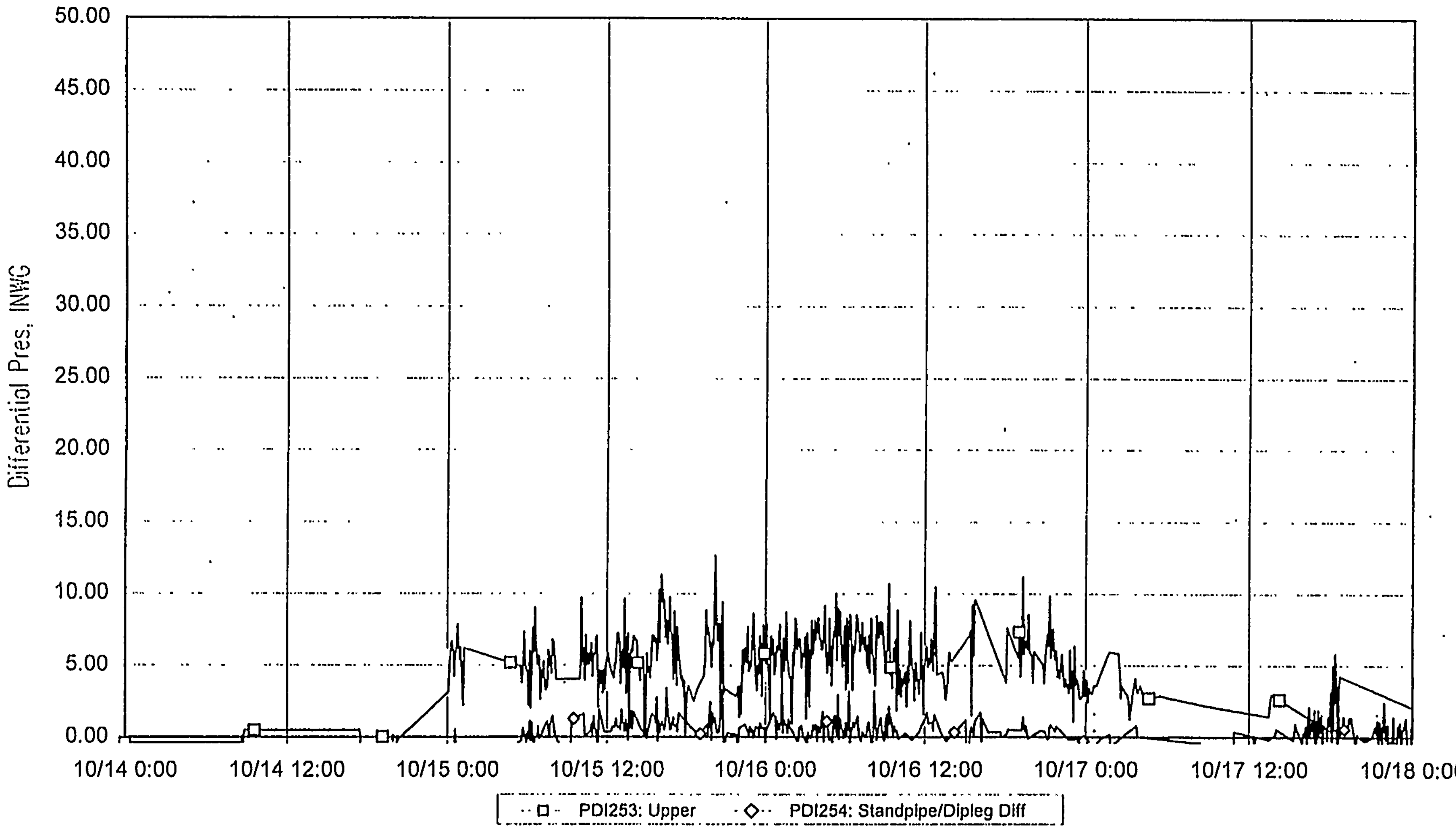
DOE Plot 21 of 45 - 5 minute data

Figure 5.1.8-36 Reactor Pressure/Riser DP Profiles for October 14 through October 17, 1996



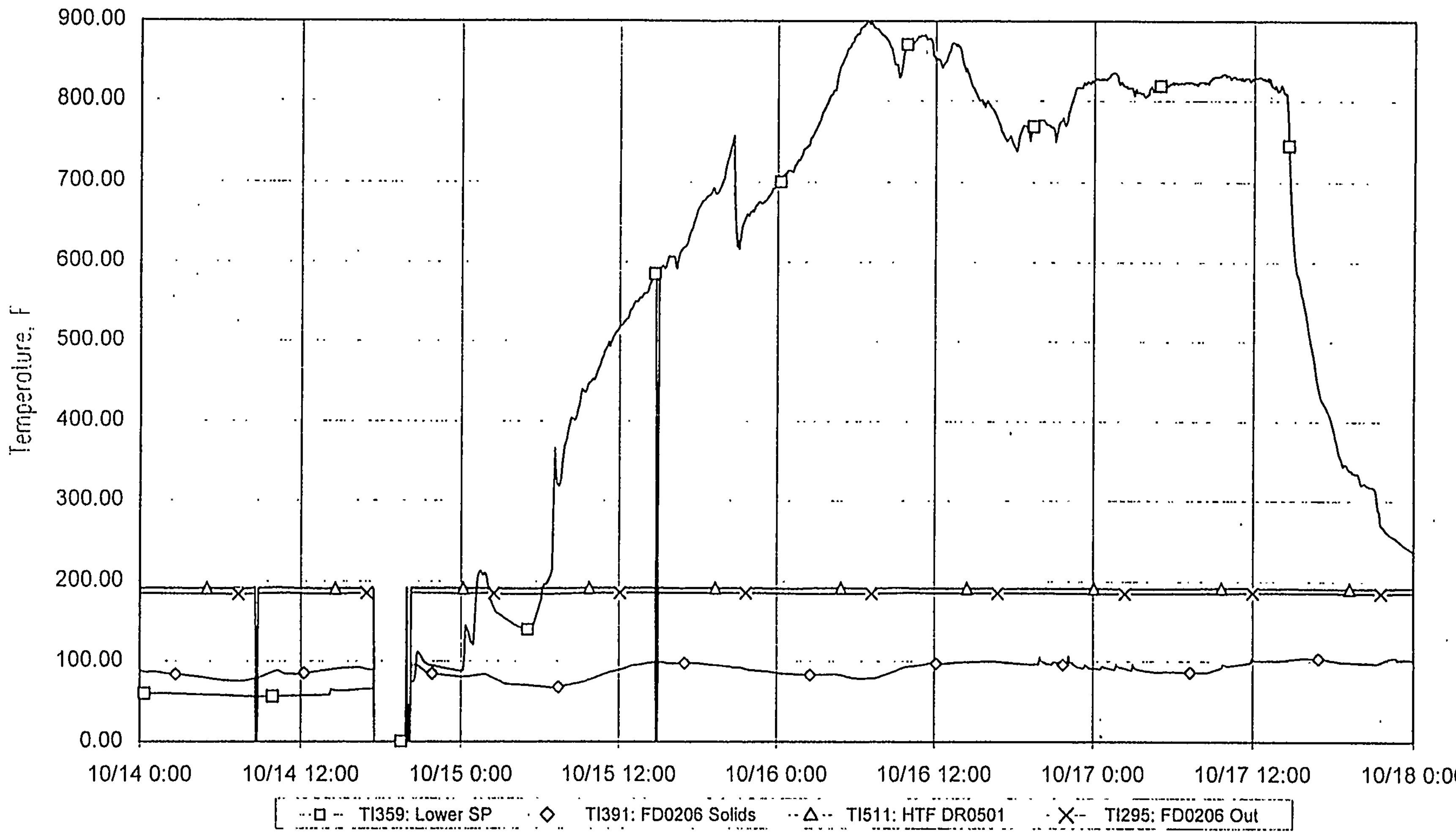
DOE Plot 22 of 45 - 5 minute data

Figure 5.1.8-37 Standpipe DP Profiles for October 14 through October 17, 1996



DOE Plot 23 of 45 - 5 minute data

Figure 5.1.8-38 CY0201 Dipleg DP Profiles for October 14 through October 17, 1996



DOE Plot 30 of 45 - 5 minute data

Figure 5.1.8-39 FD0510 Temperature Profiles for October 14 through October 17, 1996

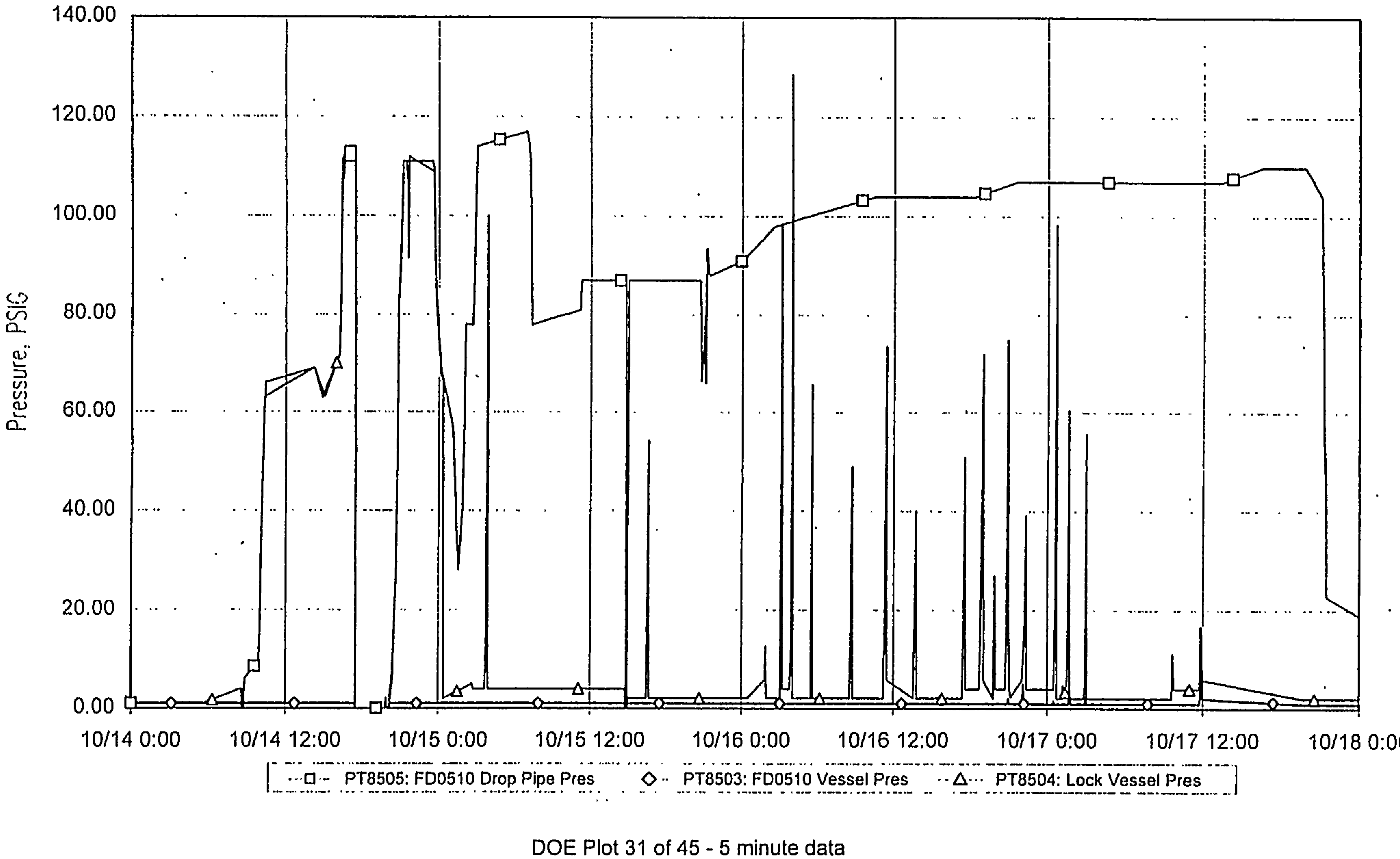
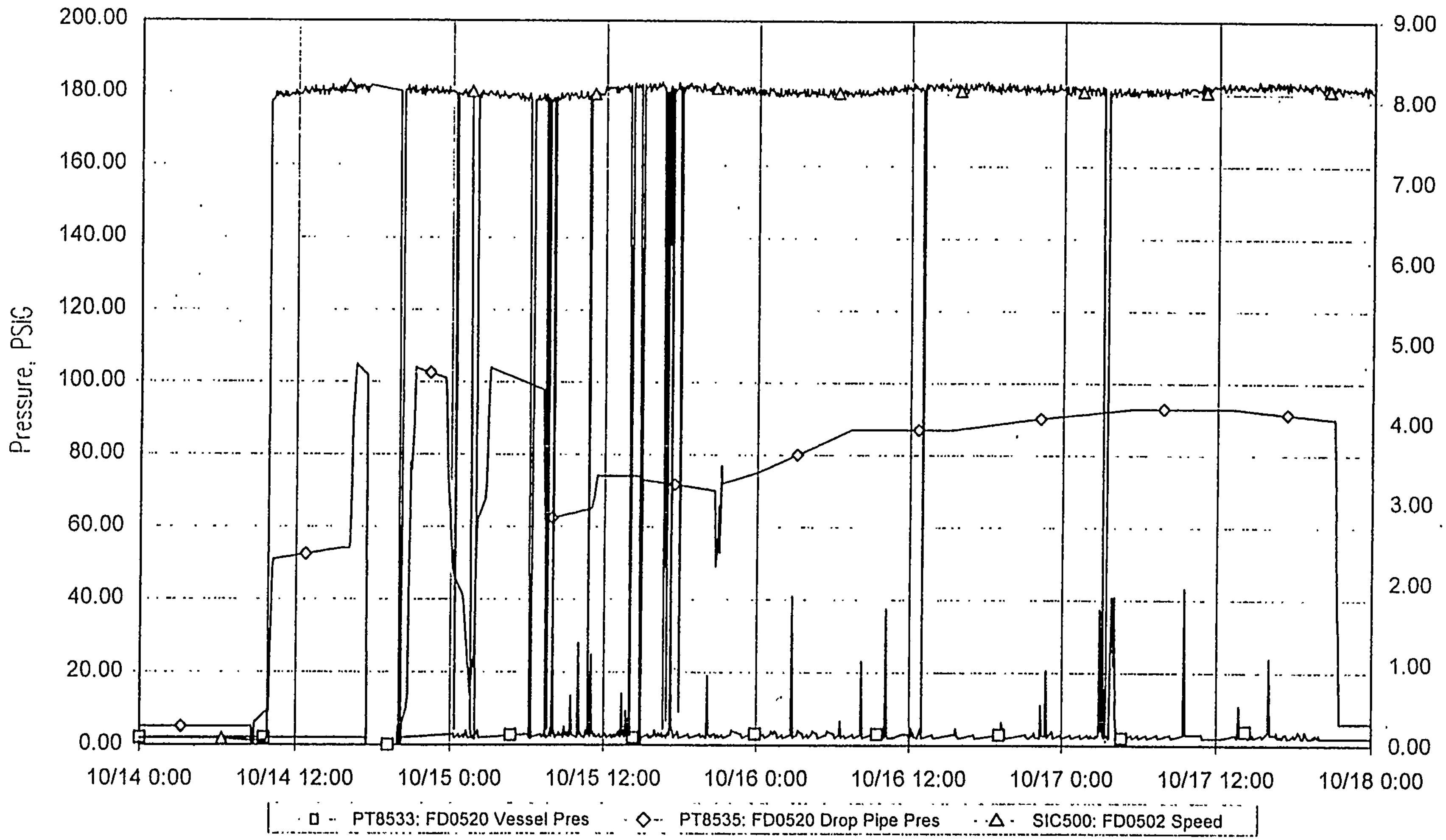
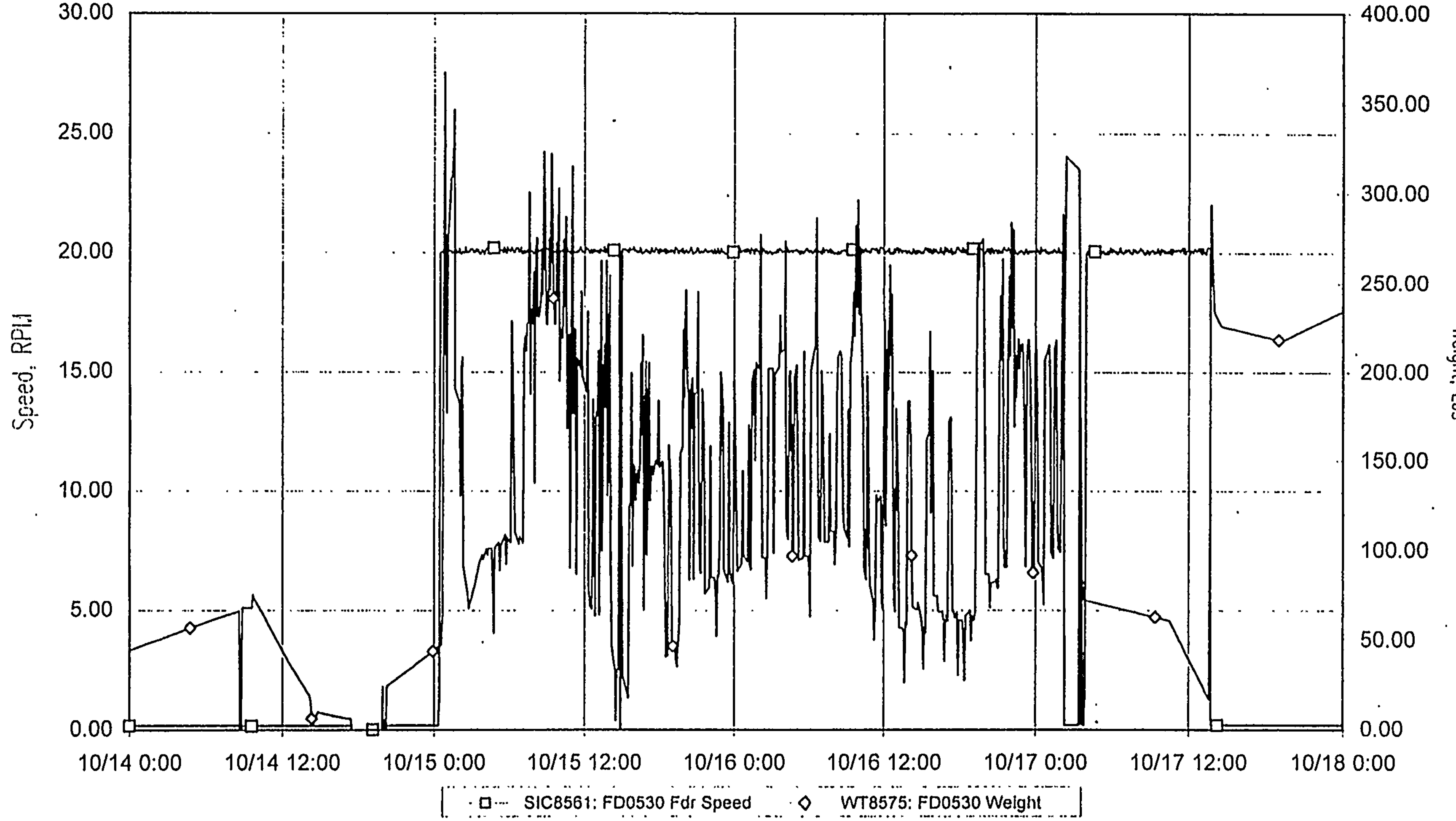


Figure 5.1.8-40 FD0206 Pressure Profiles for October 14 through October 17, 1996



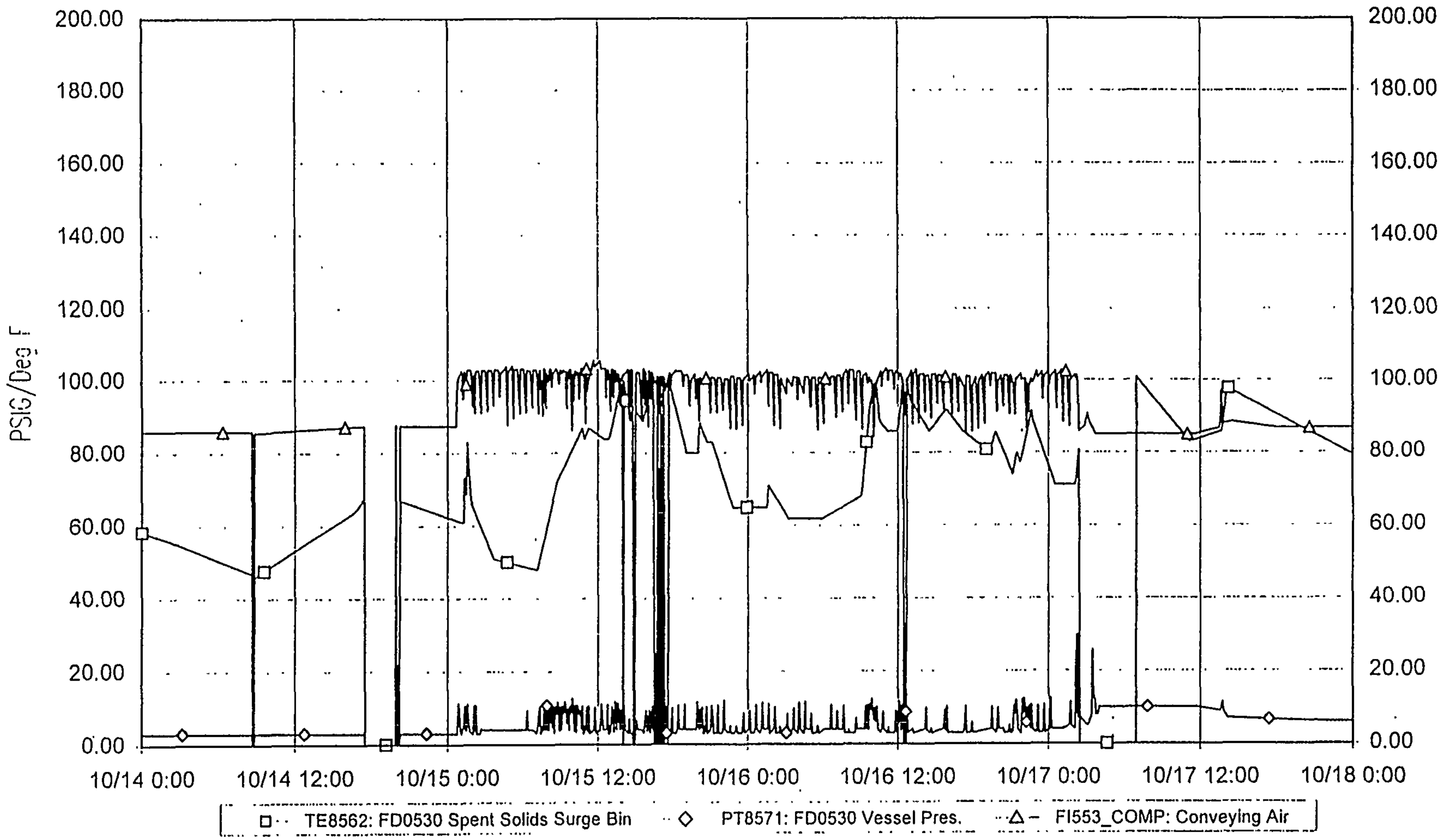
DOE Plot 32 of 45 - 5 minute data

Figure 5.1.8-41 FD0520 Pressures for October 14 through October 17, 1996



DOE Plot 33 of 45 - 5 minute data

Figure 5.1.8-42 FD0530 Feeder for October 14 through October 17, 1996



DOE Plot 34 of 45 - 5 minute data

Figure 5.1.8-43 FD0530 Feeder for October 14 through October 17, 1996

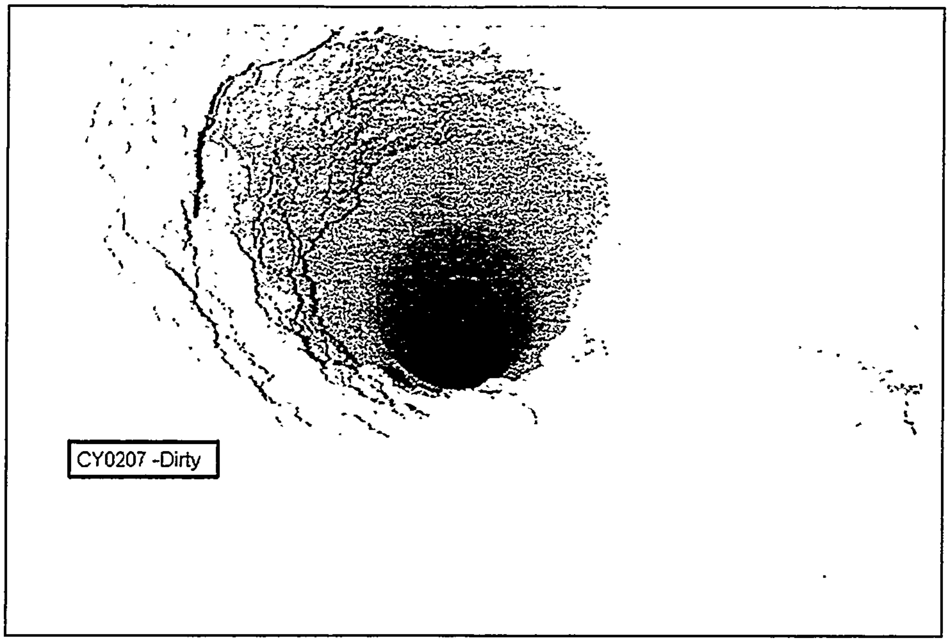


Figure 5.1.8-44 Disengager Cone Covered With Deposits

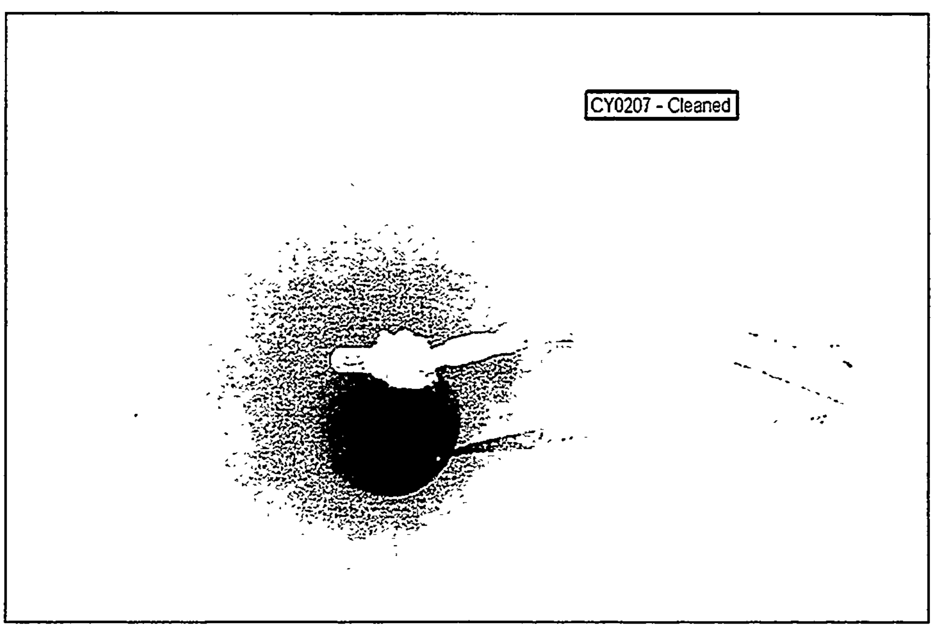


Figure 5.1.8-45 Disengager Cone After Removal of Deposits

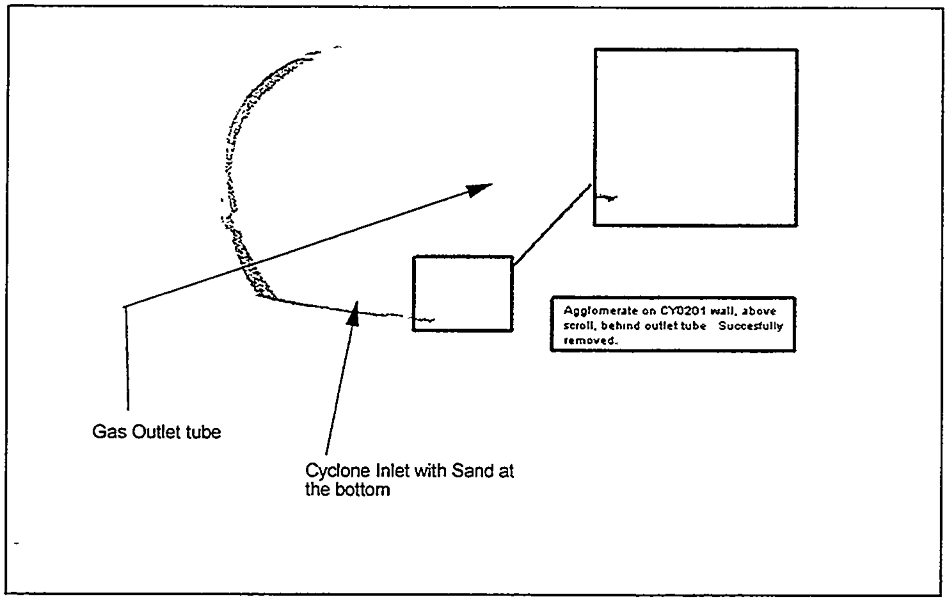


Figure 5.1.8-46 Primary Cyclone Showing Deposit Behind the Gas Outlet Tube

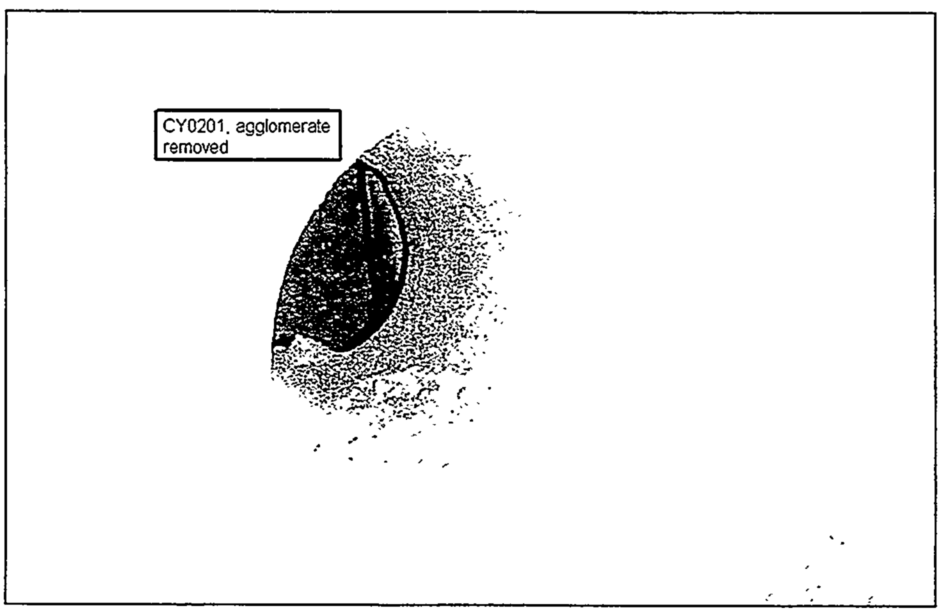


Figure 5.1.8-47 Primary Cyclone After Removal of Deposits

5.1.9 Characterization Test Run CCT2B

5.1.9.1 Introduction and Test Objective

Test run CCT2B was a continuation of the CCT2A test run. Preparation for the test run began on October 31, 1996, and the test run ended prematurely on November 8, 1996. Data for the CCT2B test run are shown in figures 5.1.9-1 to 5.1.9-21.

5.1.9.2 Test Chronology

Preparation for the run began with pressure (leak) test of the reactor loop to 300 psig on October 31, 1996. Minor leaks found at 300 psig were repaired after the reactor loop was depressurized to atmospheric pressure.

Preparation for the run continued on November 2 and 3, 1996. During this time, the Clyde solids conveying systems were tested. The discharge level probe in FD0220 was found defective. Minor leak through was discovered in PV287, but since PV287 is open during normal operation, the leak was not fixed. The transport air drier was put in service. The thermal oxidizer was started on November 2, 1996, and because it had been shutdown for more than 30 days, the manufacturer's recommended procedure for restart after a long downtime was followed.

The reactor loop was pressured to 50 psig and the primary gas cooler (HX0202) was placed in preheat mode on November 3, 1996, (after the steam drum pressure was approximately 110 psig) by closing the downcomer and opening the riser and cracking open the blowdown valve. This way, steam from the steam drum was used to preheat the PCD above the dew point before the start-up burner was lit. Shortly after, all the process temperatures downstream of HX0202 showed a sharp increase (event 1, figure 5.1.9-11). Although the main air compressor was not on at this time, nitrogen flow was established through the instrument nozzles. As soon as the HX0202 riser and downcomer were opened, the steam drum pressure dropped from 110 psig to approximately 100 psig. At this time the gas inlet temperature to the steam coils in the thermal oxidizer was approximately 1,000°F.

At approximately 09:00 the first batch of sand (starting bed material) was transferred from FD0140 into the coal feeder (FD0210). Approximately 8,000 lb were loaded into FD0210 for transfer into the reactor when needed.

About 03:00 on November 4, 1996, PCD back-pulsing was established, the main air compressor was started with its discharge pressure set at approximately 270 psig, and process flows to the reactor loop were set per operating instructions. The reactor loop pressure was increased from 50 to 60 psig and held constant at this pressure. The compressor discharge pressure was later increased to 340 psig to help clear plugged process nozzles. Approximately 9,500 lb/hr of air was routed through the mixing zone combustion nozzles to preheat the PCD to at least 2,000°F as measured by TI-439 before the start-up burner was lit (event 2, figure 5.1.9-5 and -11).

In preparation for start-up burner light off, the air flow through the mixing zone was reduced from ~9,500 lb/hr to ~4,500 lb/hr. However, some operating difficulties were encountered when BR0201 combustion air was turned on. The flow would not increase when the valve was opened. After successful troubleshooting, the burner pilot was lit at 11:40 and the burner exit temperature quickly increased to 500°F to begin a 3-hour hold per manufacturer's recommended heat up after a prolonged shutdown. Quench air was used to control the burner exit temperature to about 500°F.

At approximately 13:00 solids feeding into the reactor was initiated. Feeding was continued until all the 8,000 lb inventoried into FD0210 was transferred into the reactor (event 3, figure 5.1.9-3). The transfer took approximately 2 hours resulting in an average transfer rate of 4,000 lb/hr. Two additional batches of bed material were transferred into the reactor on November 4, 1996.

The gas temperature profiles in the mixing zone, riser, standpipe, and riser exit (including disengager and cyclone exit) are presented in figures 5.1.9-8 to -11. The initial increase in temperature (03:00 and approximately 11:00) was due to the heat from the compressor. The dip in temperature during this period was caused by the reduction in air flow in preparation for start-up burner light off. The sharp rise in temperature at 11:00 was due to the heat from the start-up burner.

Since the reactor J-leg was not sealed by solids, hot gas from the burner bypassed the riser up through the standpipe (event 4, figure 5.1.9-9). Before solids addition was started, the upper reactor J-leg aeration flows were increased and the lower aeration flows reduced to prevent the hot gases from the burner from entraining the solids collecting in the lower portion of the standpipe and thus, preventing solids accumulation there. As soon as the solids injection started, the cold solids entering the reactor cooled the hot gases from the burner and caused the reactor temperature to suddenly drop (event 5, figure 5.1.9-8 to -10). Thereafter, the reactor temperatures increased at a slower rate. During filling of the reactor standpipe, fluidization/aeration in the HX0203 loop was kept at minimum. During reactor filling and initial solids circulation, the riser and standpipe pressure differentials increased showing that solids were present (event 6, figure 5.1.9-15 and -16).

During the J-leg filling, solids migrated from the bottom of the mixing zone into the burner duct (J-leg). As the solids fill the burner J-leg, they create pressure fluctuation that affect the flame stability in the burner. Both the quench and combustion air flow rates were increased to improve the stability of BR0201 pilot flame.

As the solids level in the standpipe increased (as a result of bed material addition), the solids circulation through the reactor also increased. This in turn increased the solids loading to the cyclone system. By the time the first 8,000-lb batch of bed material transfer into the reactor was completed, the loading to the PCD increased as result of increased solids loading to the disengager/cyclone system. Around 14:45 bed material feeding into the reactor was temporarily stopped to allow the material captured by the PCD to drain out through the fines screw cooler (FD0502) which was running at 12 rpm (~15 percent above design). The draining of the PCD cone was trended using the pressurization and depressurization of FD0520 lock vessel below the fines screw cooler (event 7, figure 5.1.9-12). Each dump cycle was equivalent to approximately 140 lb of material. 14:30 and 15:00 when solids feeding was stopped, FD0520 cycled approximately six times corresponding roughly to 840 lb of solids lost at a rate of 1,680 lb/hr. As the solids loss continued from the reactor system, the solids level in the standpipe dropped. The riser superficial velocity that was 33 ft/s at 16:15 was reduced to 25 ft/s to bring the velocity to design point and allowed observation of the solids separation system performance.

Solid samples were taken from the discharge of the PCD and analyzed for their particle size distribution and bulk densities. The results are plotted in figure 5.1.9-22 which shows that the geometric mean size (except for the sample taken at 16:00) was not significantly different from the feed sand. A similar trend was observed in the test run CCT1C in October 1996.

After the PCD cone was cleared of solids (at 15:00), the second batch of bed material inventoried in FD0210 was fed into the reactor. Again as noted previously, as soon as the bed level in the standpipe began to increase, the solids loss rate from the reactor to the PCD increased as indicated by the closeness of the pressurization/depressurization pulses from FD0502 (event 8, figure 5.1.9-12). The second batch of bed material transfer was completed at about 19:00. the start and completion of material transfer into the reactor, the FD0502 lockvessel cycled approximately 20 times giving a loss rate of approximately 1,400 lb/hr. At 17:45 the riser superficial velocity was increased from 25 ft/s back to ~33 ft/s in an attempt to increase the cyclone inlet velocity and improve its collection efficiency. Around this time, sand feeding into the reactor was stopped. However, because the standpipe solids level was high, solids circulation through the reactor loop was also high resulting in continuous loss of solids from the reactor to the PCD as the cyclone system was not operating efficiently. The standpipe solids level continued a steady drop and leveled out a around 18:00. Once this happened, solids carryover to PCD was also reduced. 18:00 and 20:30 when the next batch of coarse sand was added, FD0520 cycled only about 4 times giving a loss rate of approximately 220 lb/hr. At 19:00 FD0210 was deinventoried of fines sand (geometric mean of 189 μm) and coarse sand with a geometric mean of 254 μm (see figure 5.1.9-23 for size distribution) was loaded. Coarse sand was used in an attempt to increase the collection efficiency of the solids separation system thereby retaining a higher proportion of the feed in the bed and reduce sand makeup into the reactor.

At approximately 20:30 the transfer of the coarse sand inventoried in FD0210 into the reactor began. As soon as the standpipe level began to increase from its steady value, solids carryover to the PCD again increased. Solids transfer was stopped around 22:15. At around 20:30 and 23:30, FD0520 cycled 15 times giving a loss rate of 600 lb/hr. The solids loss appeared to taper off as the standpipe solids level returned to its previous steady state level. The solids sample from the FD0520 dump had a geometric mean of 178 microns. Its size distribution is shown in figure 5.1.9-23 together with the coarse feed sand size distribution.

While solids were being fed into the reactor, the burner pilot firing rate was held constant (on pilot only). Also the combustor heat exchanger was fluidized but was not circulated. Fluidization to HX0203 J-leg was maintained at minimum. From the PDT profile, it appeared that some of the material added to the standpipe was transferred into the heat exchanger. The FD0206 was operated for a brief period every 2 hours and FD0510 was periodically cycled to prevent moisture condensation in the spent solids discharge system.

At approximately 01:20 the next day (November 5, 1996), an attempt was made to start solids circulation through the combustor heat exchanger loop. The HX0203 dilute-phase pressure control valve (PDV384) was opened 100 percent from previously fully closed position. In an attempt to initiate solids circulation, air flow through FIC680 (HX0203 J-leg aeration) was started. However, most of the J-leg nozzles were found plugged with solids. Several attempts made to blow clear the nozzles at 60 psig were unsuccessful. The reactor was subsequently depressurized to 40 psig and some of the nozzles were cleared. Solids circulation through HX0203 was started at around 10:00; however, one of the boot fluidization nozzles remained plugged.

Operating conditions were maintained essentially "steady" until at around 14:30 when the main burner gun was lit (event 9, figure 5.1.9-15). The burner propane flow and outlet temperature is shown in figure 5.1.9-5. After the main burner gun was lit, the burner firing rate was maintained constant for the rest of the day. The reactor loop temperatures increased after the main burner was lit (event 9, figure 5.1.9-8 to -11). Other reactor and temperatures downstream of the cyclone also show an increase when the main burner was lit. Prior to this, the solids circulation rate steadily decreased as the material lost to the PCD was not recycled back into the reactor. Neither was fresh material fed into the reactor. The average solids loss rate (00:00 and 14:00) was approximately 150 lb/hr. The FD0520 lockvessel had only 15 dumps during this period. The size distributions of solids samples taken from the PCD drain on November 5, 1996, are plotted in figure 5.1.9-24. In addition to samples from FD0520, composite material transferred from FD0530 into the ash silo was sampled and their size distributions determined. These samples were used to determine if the samples from FD0520 outlet were representative of the solids captured by the PCD since these samples were taken in situ while material was being transferred in dense-phase mode from FD0520 into FD0530.

At approximately 15:00 the reactor loop pressure was increased from 60 to 80 psig and then to 100 psig at around 17:00. Before the reactor pressure was increased each time, the propane supply and the burner pilot differential pressures were increased. This was done to increase propane flow rate through the pilot and move the flame front away from the pilot tip and prevent the tip from burning up.

To stop the continuous drop of solids level while additional make-up solids were not being injected into the bed and also to reduce thermal stress the reactor loop and the HX0203 loop, the HX0203 solids were circulated after 15:00 on November 5, 1996. This additional circulation from the heat exchanger caused the riser and mixing zone densities to increase. The additional material transferred from HX0203 into the standpipe increased the solids level in the standpipe (event 10, figure 5.1.9-15 and -16). After a brief period, solids circulation from HX0203 dropped because the heat exchanger standpipe was not adequately fluidized. Some of the aeration nozzles were still plugged. All HX0203-related aeration nozzles were made operational by 18:00 and solids circulation rate through HX0203 was resumed. At about 22:00 the solids loss rate to the PCD was rapidly increasing and the heat exchanger solids circulation was reduced through manipulation of the aeration/fluidization flows. The increase in solids circulation through HX0203 resulted in a sharp increase in HX0203 solid and vapor-phase temperatures as hot solids from the standpipe entered the heat exchanger.

After the process temperatures inside HX0203 were close to 300°F, the burner firing was increased at 00:28 on November 6, 1996. At that time, the HX0203 skin temperatures were such that the differential temperature it and the reactor loop was within limits. Skin temperature profile taken at 01:00 showed a difference of 50°F HX0203 loop and the reactor loop compared to a maximum of 135°F allowed. The second skin temperature survey taken at 07:30 showed the differential skin temperatures the riser-mixing zone and standpipe was 11°F, primary cyclone loop and standpipe was 3°F, the standpipe and HX0203 loop was 19°F, and HX0203 loop and riser-mixing zone was 30°F. The results of the skin temperature surveys taken during the test run are summarized in table 5.1.9-1.

Reactor heat up was continued by increasing the burner firing. Flow adjustments were made to maintain a reasonable solids circulation through the reactor without excessive solids carryover. The reactor pressure was kept constant at 100 psig. At around 13:00 the data acquisition system (PI system) crashed, but was brought back on-line around 23:00. While the PI system was being serviced, the reactor heat up continued. About 23:30 the mixing zone temperatures were above 1,000°F and preparation for coke breeze/coal assisted preheat began.

About midnight on November 7, 1996, the sorbent feeder (FD0220) was inventoried with coke breeze and subbituminous coal mixture (3/1 wt ratio). It was planned to use the coal feeder for bed material makeup. Feeding from the sorbent feeder would permit a better control over the fuel feed rate during start-up because the feed rate from FD0220 is much lower than from FD0210. The minimum feed rate for FD0210 is 400 lb/hr compared with estimated 20 lb/hr of coal (50 lb/hr of dolomite) for FD0220.

midnight and 02:00 coke breeze/coal feeding from FD0220 into the reactor was attempted but the feeder did not operate. Large pieces of coal were later found blocking the discharge of the feeder. These pieces got mixed with the coke breeze/coal when the two were mixed on the concrete floor near the coal pile. These large particles dropped through the unsealed gap around the edges of the screen installed on top of FD0140. Sand remaining in FD0210 was subsequently drained.

The coke breeze/coal mixture was also drained from FD0220. The fuel mixture was rescreened and loaded into FD0210 for feeding into the reactor. Approximately 1,000 lb of coke breeze/coal mixture was loaded into FD0210.

At approximately 05:00 a coke breeze/coal mixture was fed batchwise into the reactor. After the first batch of coke breeze/coal mixture was injected into the reactor, the second batch of approximately 1,100 lb of coke breeze/coal mixture was loaded into FD0210. At 07:30 continuous feeding into the reactor was started. The combustion heat exchanger up to this time, was circulated periodically for a short time to heat up the HX0203 loop. As the coke breeze/coal mixture feed injection continued, the reactor loop temperature began to increase. To control the temperature rise, continuous solids circulation through the combustor heat exchanger was started. However, as soon as the solids circulation through the heat exchanger started, the solids carryover rate to the PCD increased (event 11, figure 5.1.9-12). 07:45 (when continuous HX0203 circulation started) and 12:20, approximately 3,800 lb of material was lost from the reactor loop at an average rate of 830 lb/hr, mostly from HX0203. The size distributions of the solids carryover from the reactor are shown in figure 5.1.9-25. After stable combustion was achieved, the start-up burner was shutdown at approximately 10:00 (event 12, figure 5.1.9-5).

To control reactor temperature without increasing solids loss, HX0203 solids circulation was reduced and air flow was established through the riser staged air nozzles to provide some cooling and help maintain reactor temperature 1,450 and 1,600°F. Also, reactor feeding was switched from continuous to batch mode. When the reactor temperature reached 1,600°F, the coke breeze/coal mixture feeding was stopped and when the temperature dropped to 1,400°F, feeding was resumed.

At 14:30 the FD0502 tripped. Being unable to discharge solids from the PCD hopper, the coke breeze/coal feeding was stopped and the solids circulation through the reactor was reduced to allow the PCD cone to be cleared of solids after FD0502 was restarted. The reactor temperatures also dropped due to loss of coke breeze/coal feed. At 15:00 the PCD appeared to be empty of solids. The attempted relighting of the start-up burner was unsuccessful at 100 psig. The reactor pressure was therefore reduced from 100 to 70 psig. The start-up burner was lit at 70 psig and reactor reheat was resumed. After approximately 2 hours, the start-up burner tripped again. After several unsuccessful attempts to light the burner (including relighting at a reduced reactor loop pressure) the test was prematurely terminated. The reactor temperatures were too low for coke breeze/coal mixture to ignite.

5.1.9.3 Test Run CCT2B Observations

In this test run the primary gas cooler was successfully used for the first time as a condensing heater during startup to preheat the PCD. Excessive solids carryover to the filter vessel continued to plague operations. The size distribution of the solids from the filter vessel was nearly the same as that in the reactor. A coarser inert bed material was tried without much success to reduce loss of reactor solids. The solids loss rate from the reactor increased as the solids level in the standpipe was increased to seal the cyclone dipleg. As a result it was difficult to maintain high solids level in the standpipe. A mixture of coke breeze and subbituminous coal was used to transition from propane firing to coal firing. The reactor temperature was successfully increased in this manner from 1,000 to 1,600 °F without accumulating any carbon in the reactor.

Table 5.1.9-1

Results From Reactor Loop Skin Temperature Surveys

Date	11/6/96	11/6/96	11/7/96
Start Time	06:30	14:00	07:35
End Time	07:30	15:08	08:35
Riser Exit Temperature, °F	750	925	1100
Average Riser/Mixing Zone Skin Temperature, °F	134	169	179
Average Standpipe Skin Temperature, °F	123	148	166
Average Cyclone Skin Temperature, °F	127	149	160
Average HX0203 Loop Skin Temperature, °F	104	117	115
Differential Temperature °F s			
Riser/Mixing Zone and Standpipe	11	21	13
Standpipe and Cyclone	-3	-1	6
Standpipe and HX0203 loop	19	31	52
Riser/Mixing Zone and HX0203 Loop	30	52	64

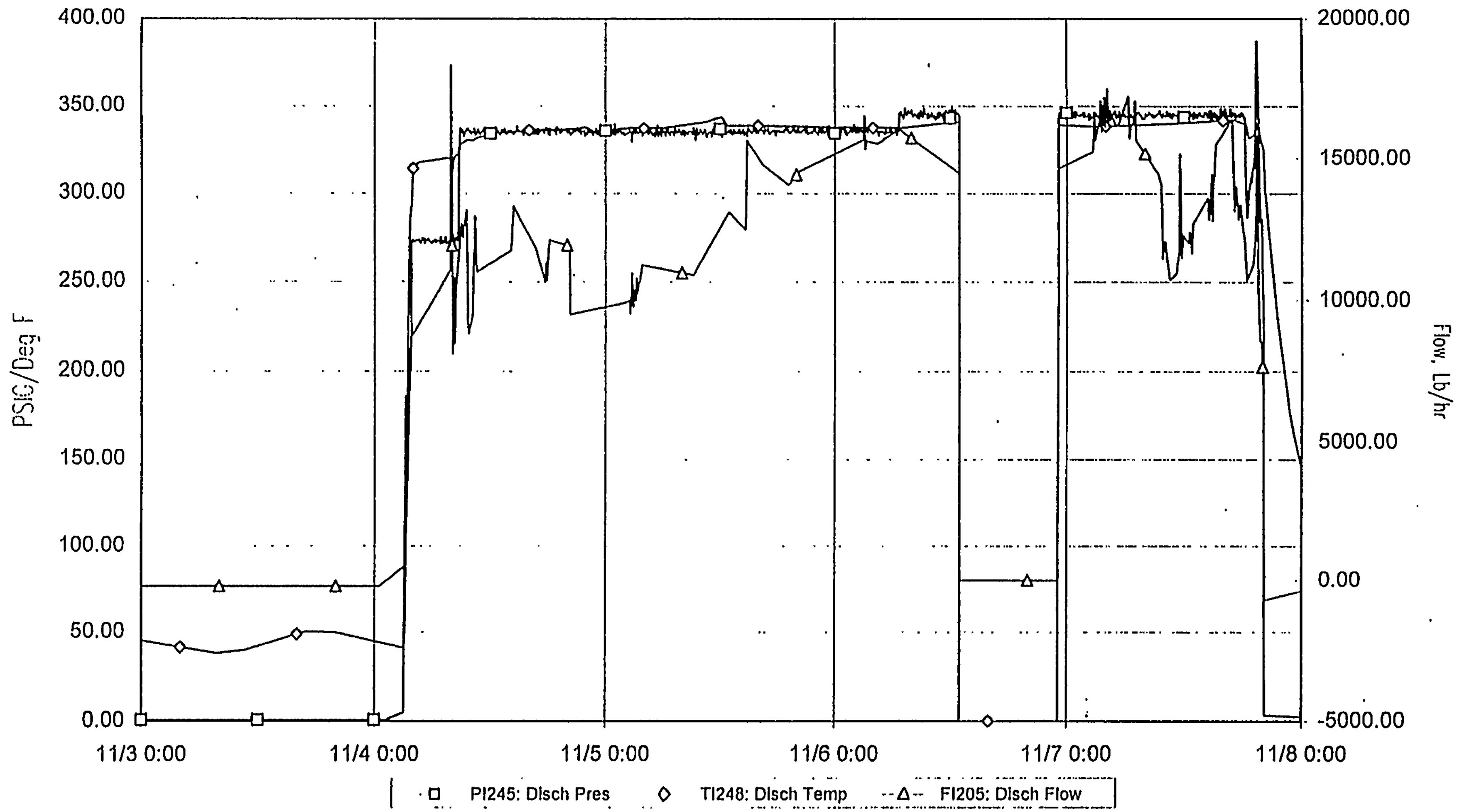
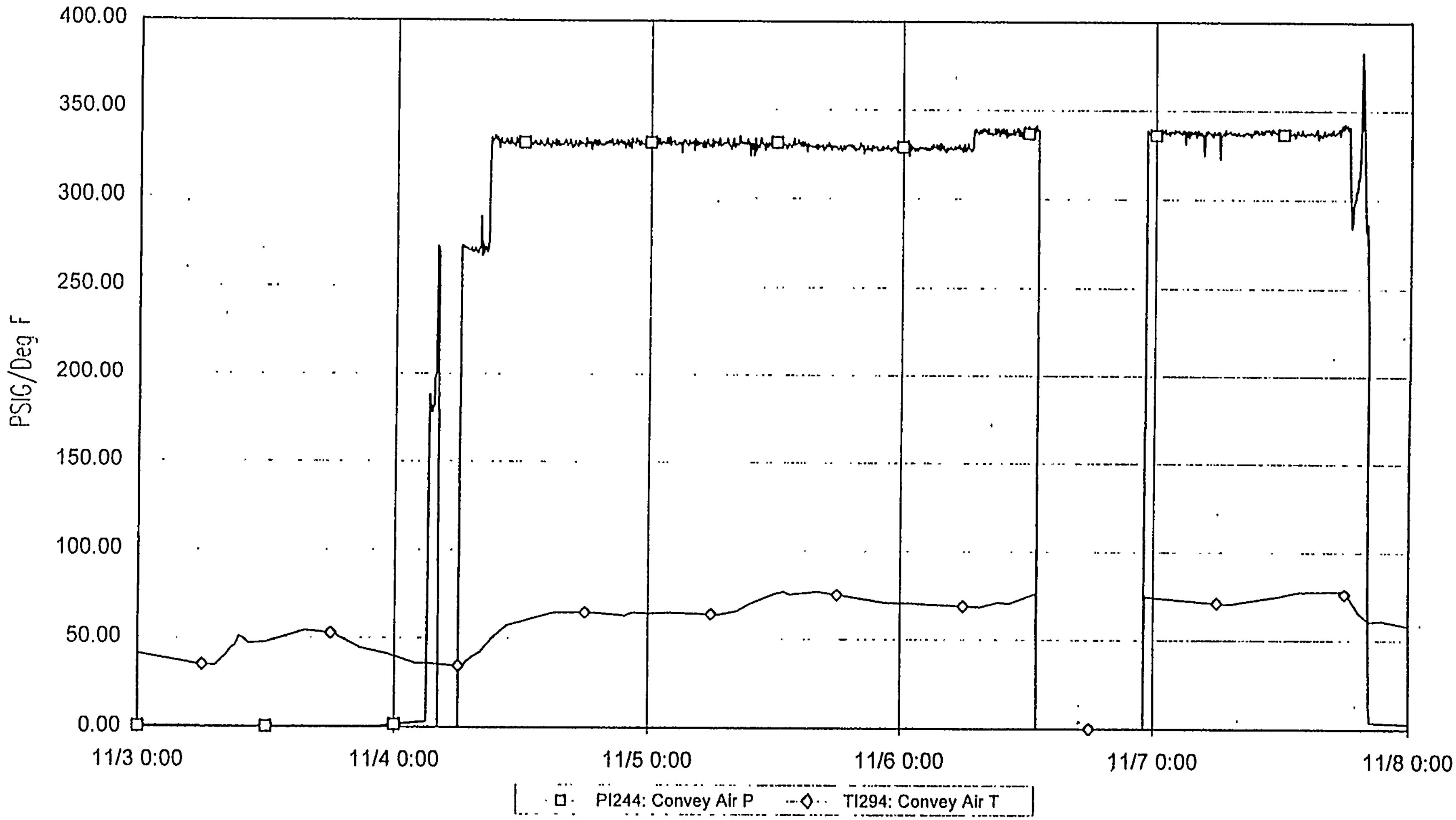
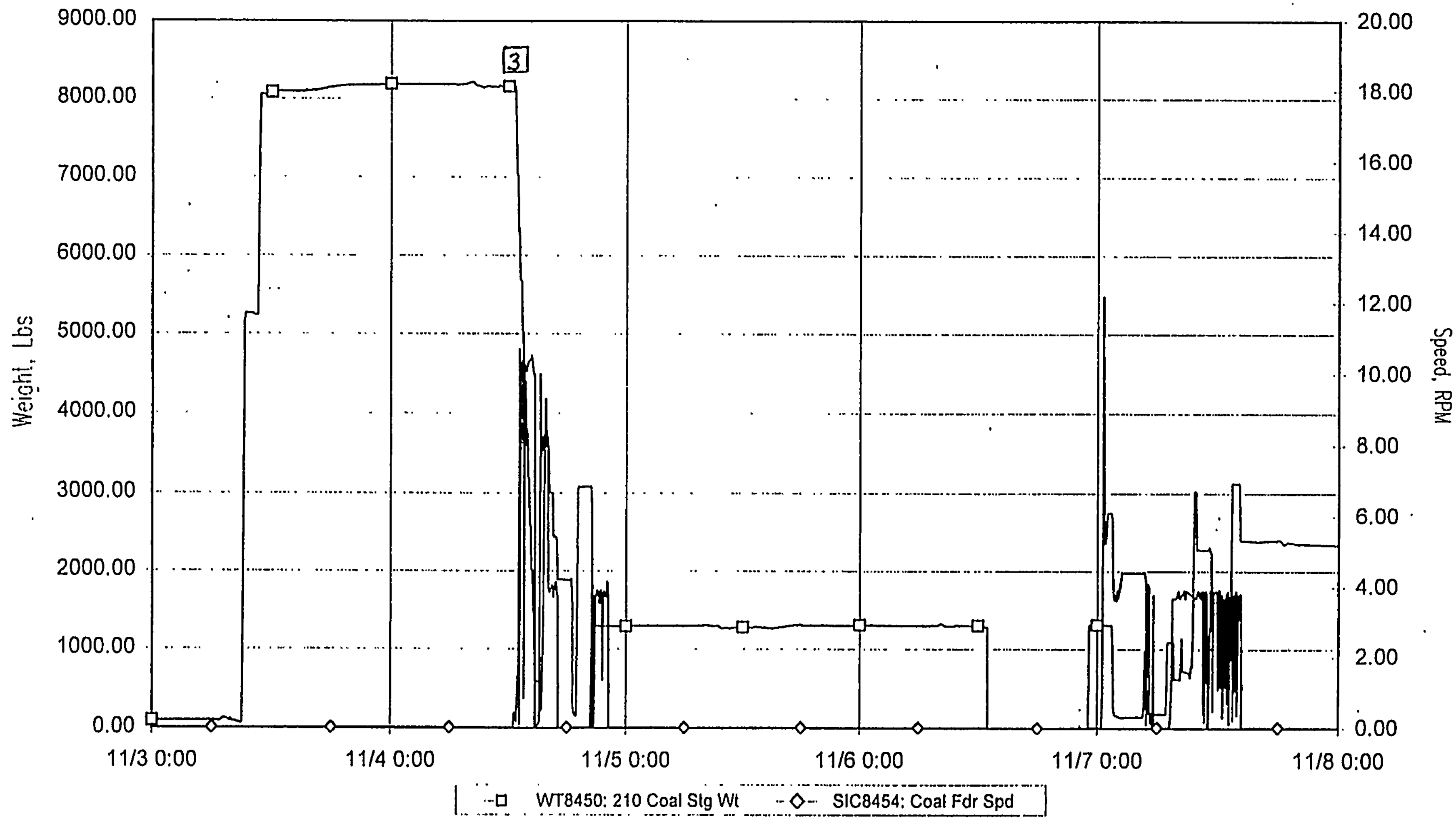


Figure 5.1.9-1 C00201 System Profile for November 3 Through November 7, 1996



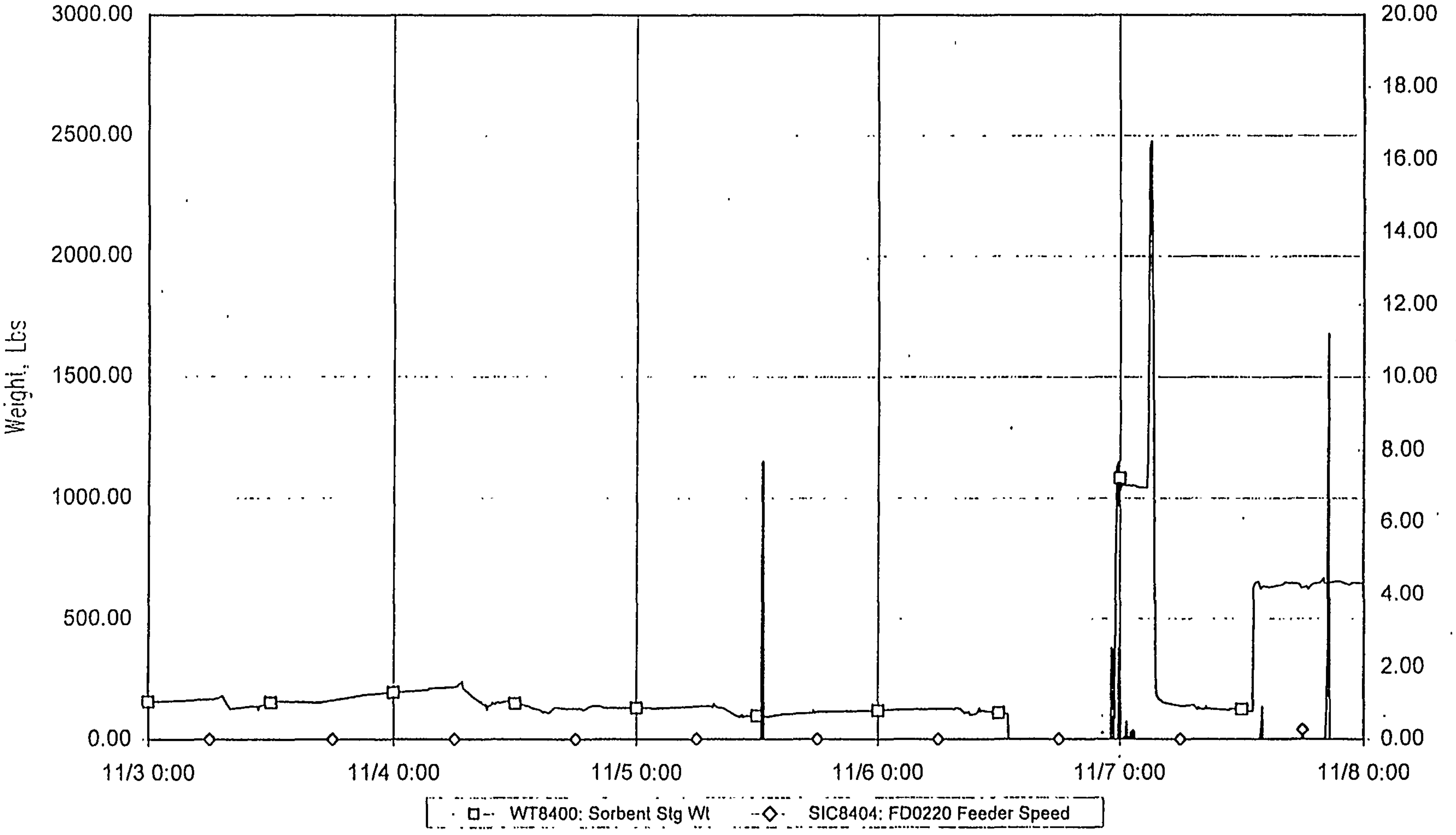
DOE Plot 5 of 45 - 5 minute data

Figure 5.1.9-2 Transport Air System for November 3 Through November 7, 1996



DOE Plot 7 of 45 - 5 minute data

Figure 5.1.9-3 Coal Feed for November 3 Through November 7, 1996



DOE Plot 9 of 45 - 5 minute data

Figure 5.1.9-4 Sorbent Feed for November 3 Through 7, 1996

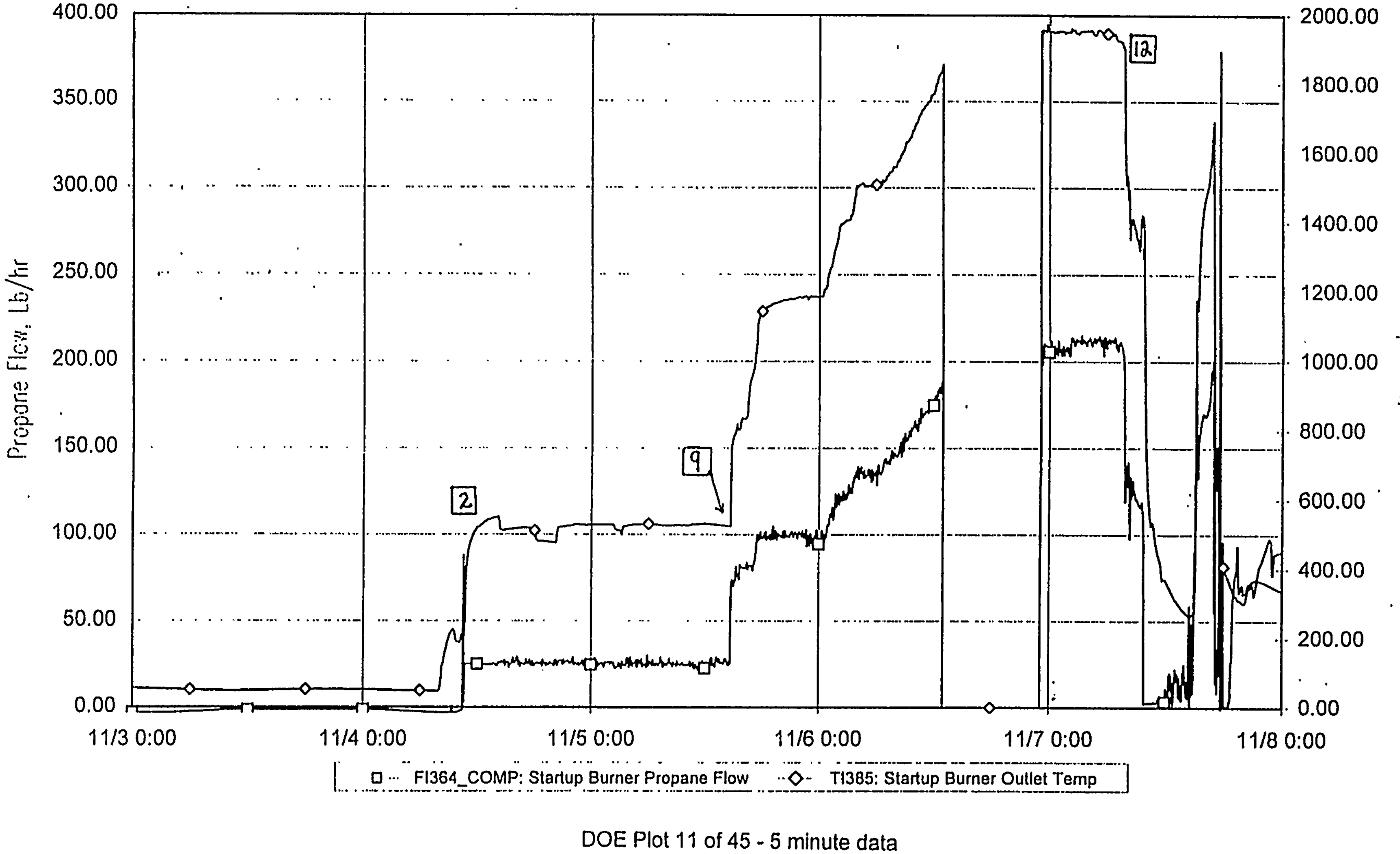


Figure 5.1.9-5 Start-Up Burner Flow/Temperature for November 3 Through November 7, 1996

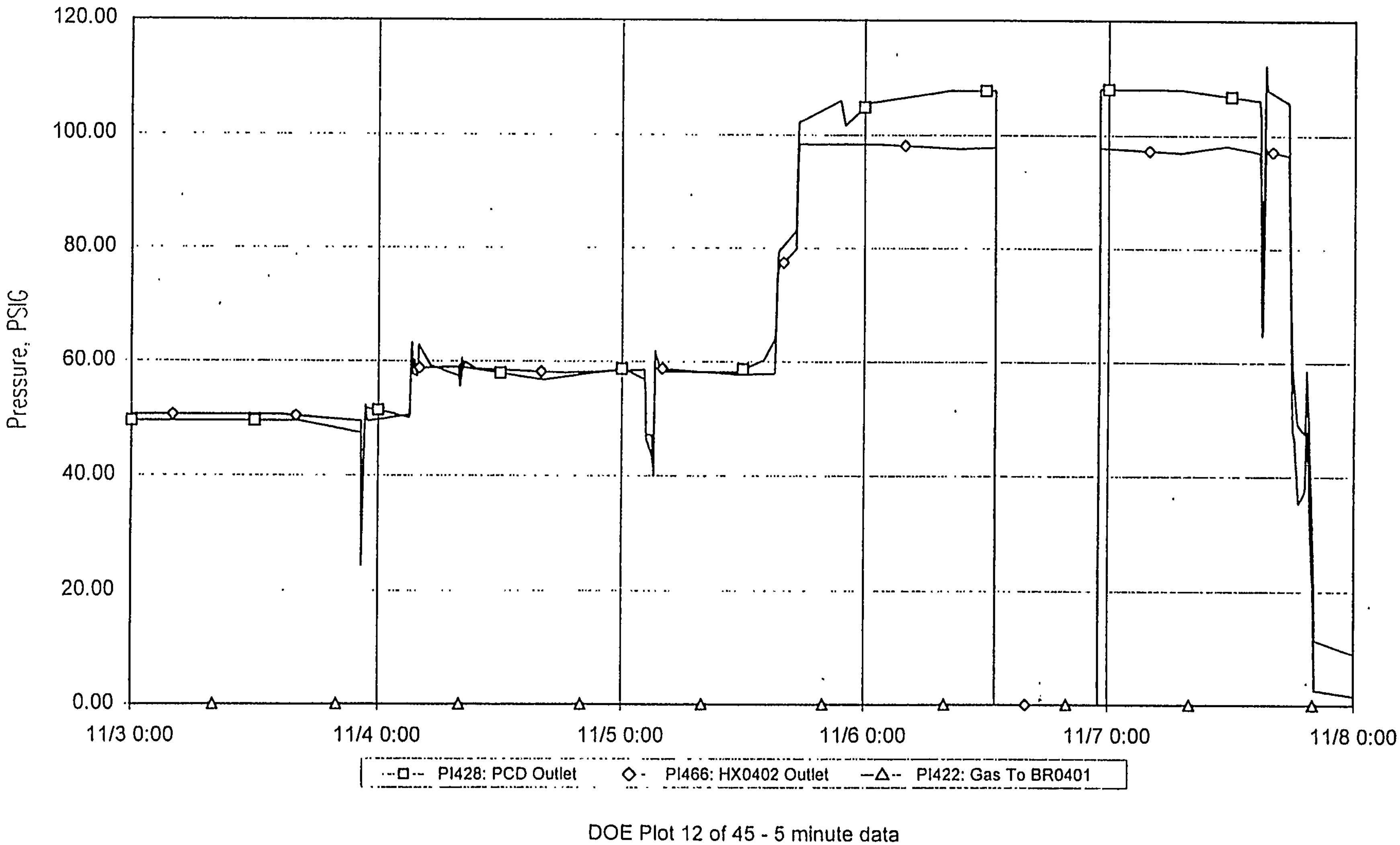
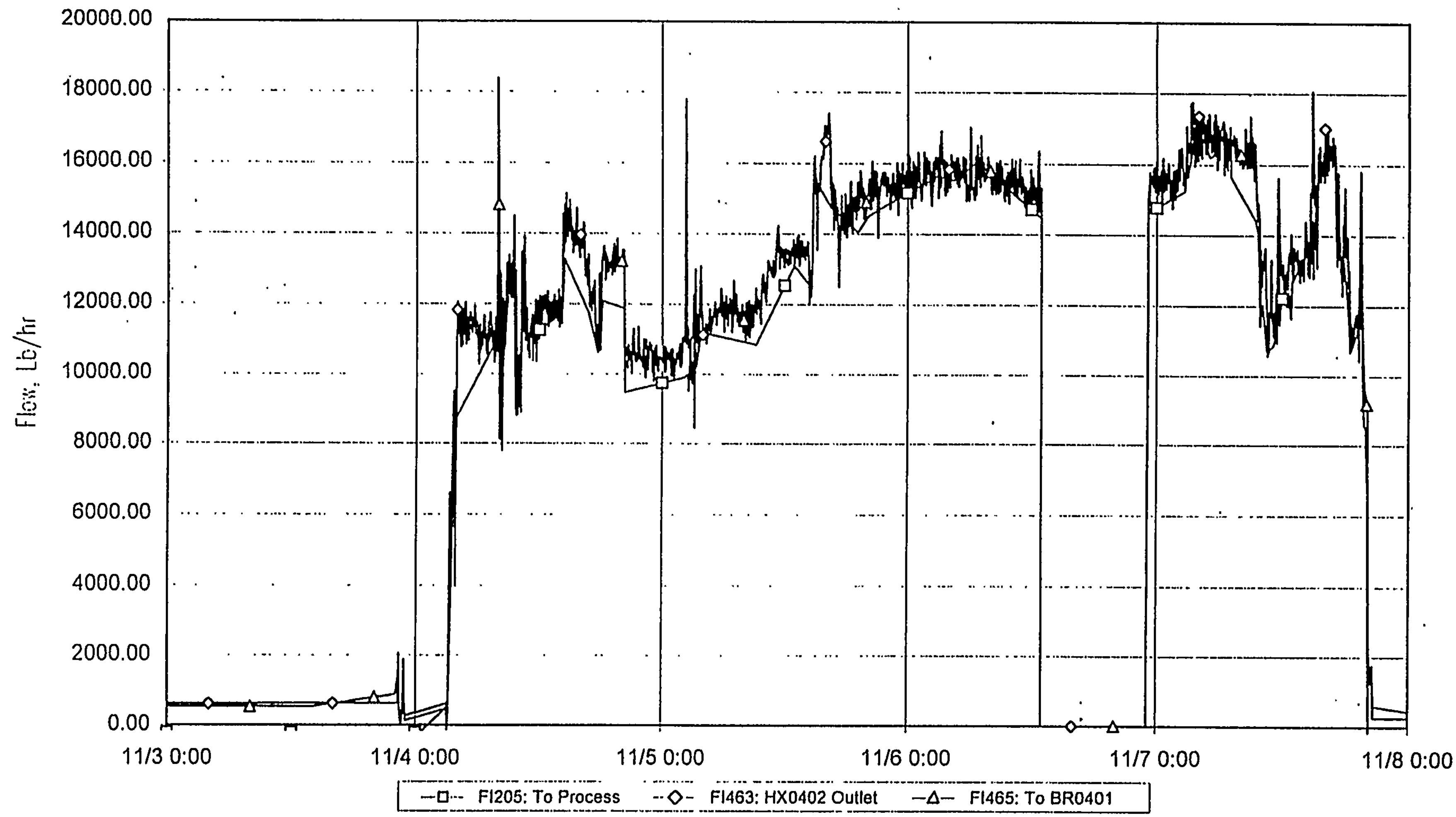


Figure 5.1.9-6 System Pressures Downstream of PCD for November 3 Through November 7, 1996



DOE Plot 13 of 45 - 5 minute data

Figure 5.1.9-7 Total Gas In/Out Flow Rates for November 3 Through November 7, 1996

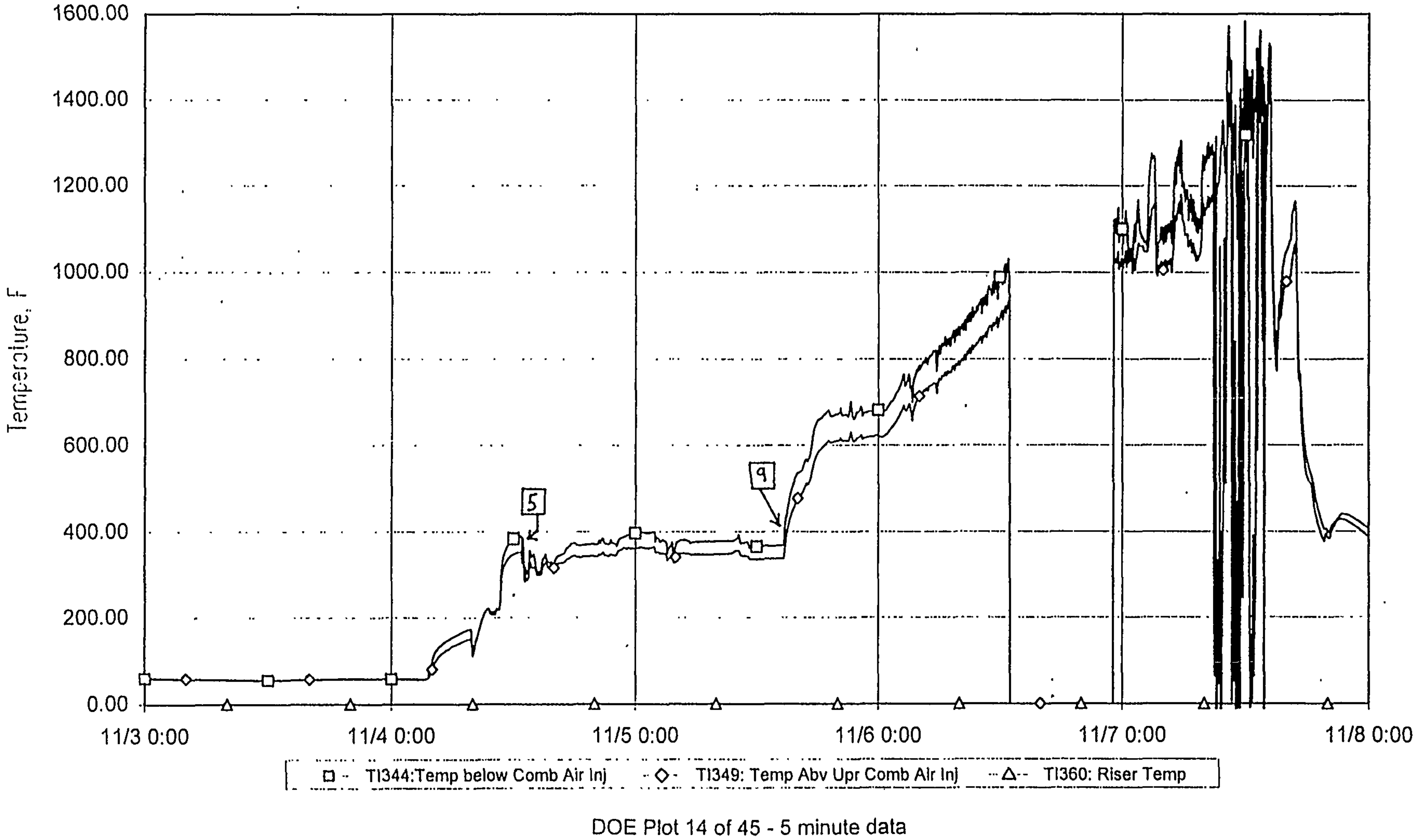


Figure 5.1.9-8 Reactor Mixing Zone and Riser Temperatures for November 3 Through November 7, 1996

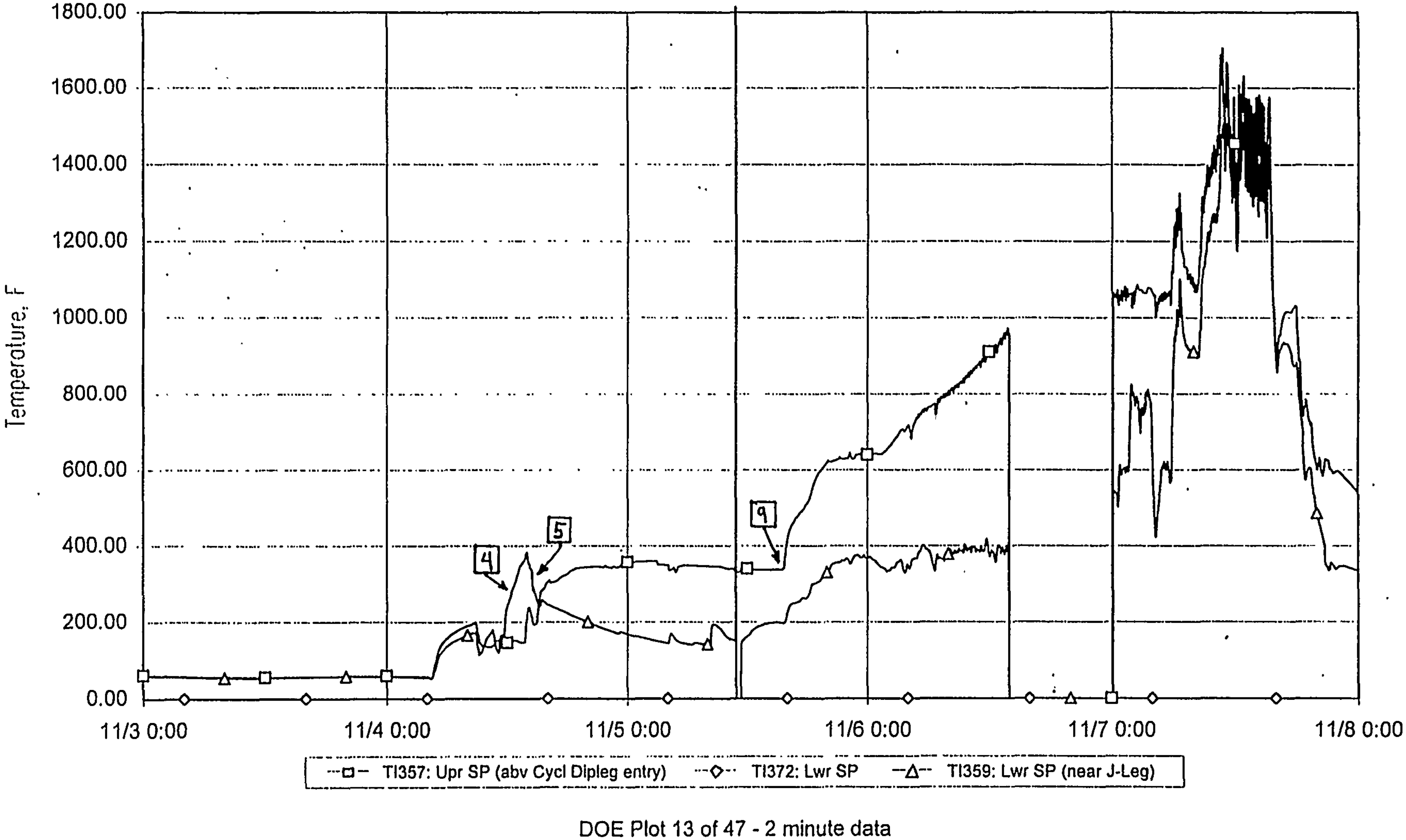


Figure 5.1.9-9 Standpipe Temperatures for November 3 Through November 7, 1996

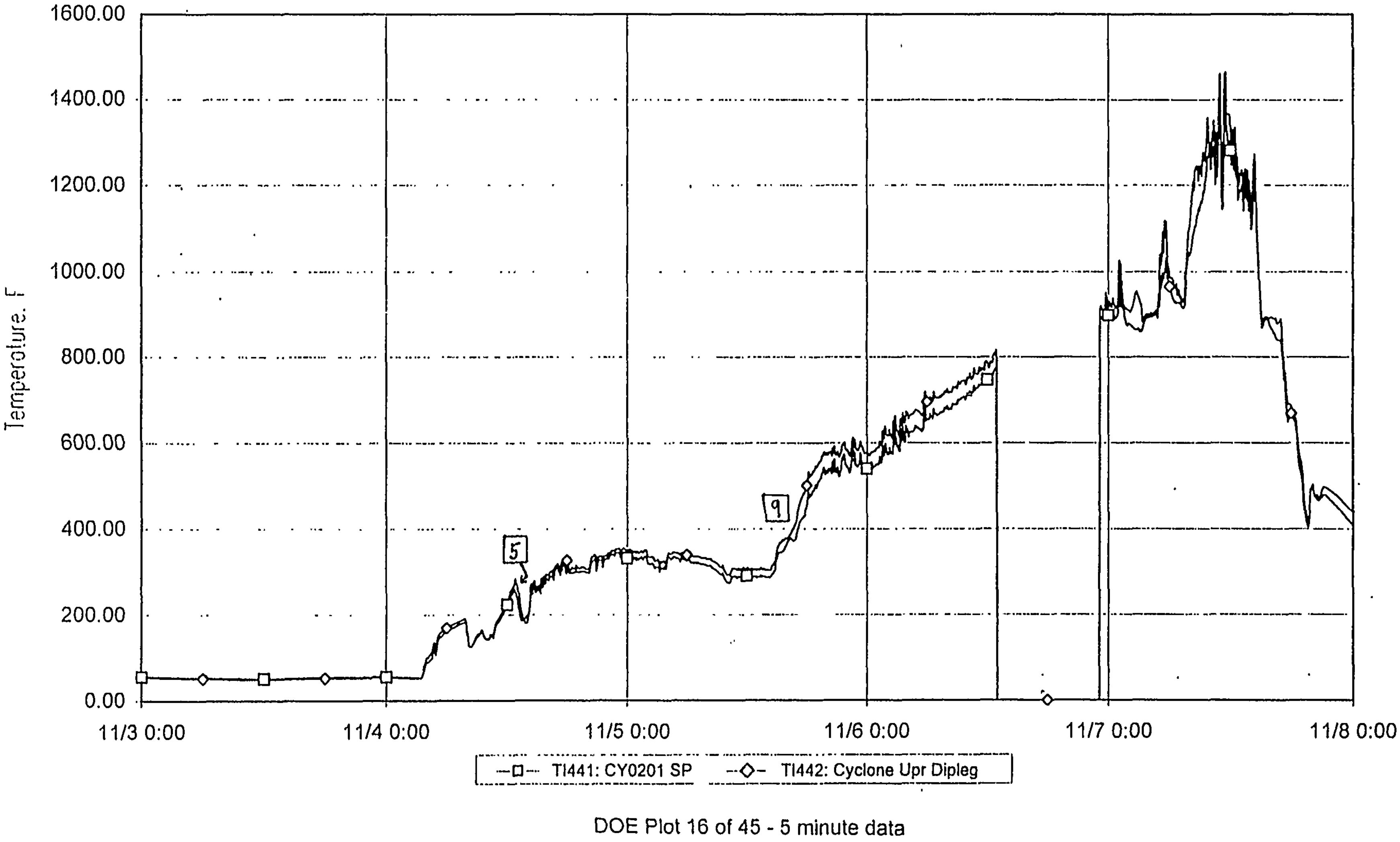


Figure 5.1.9-10 Cyclone Dipleg Temperatures for November 3 Through November 7, 1996

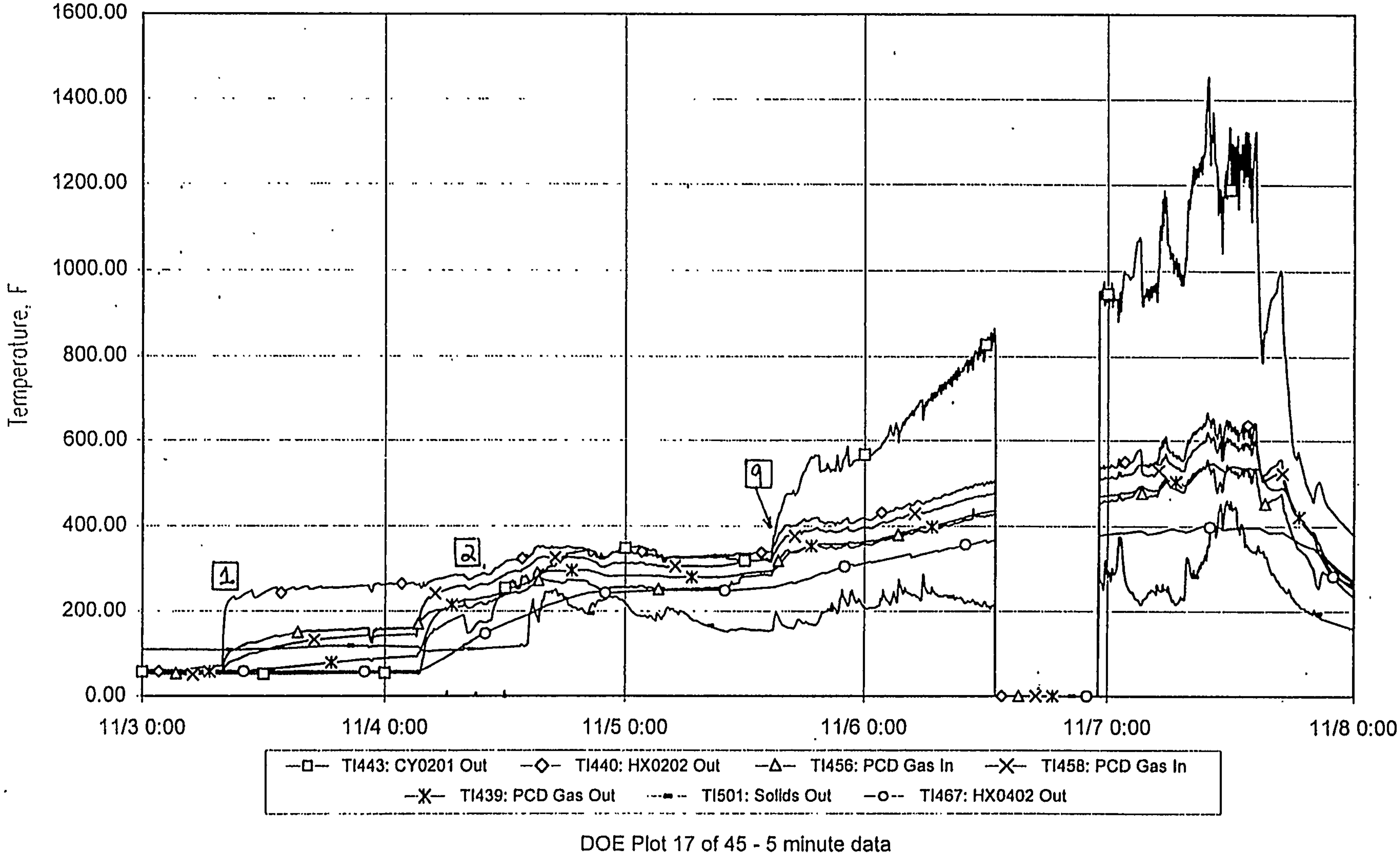
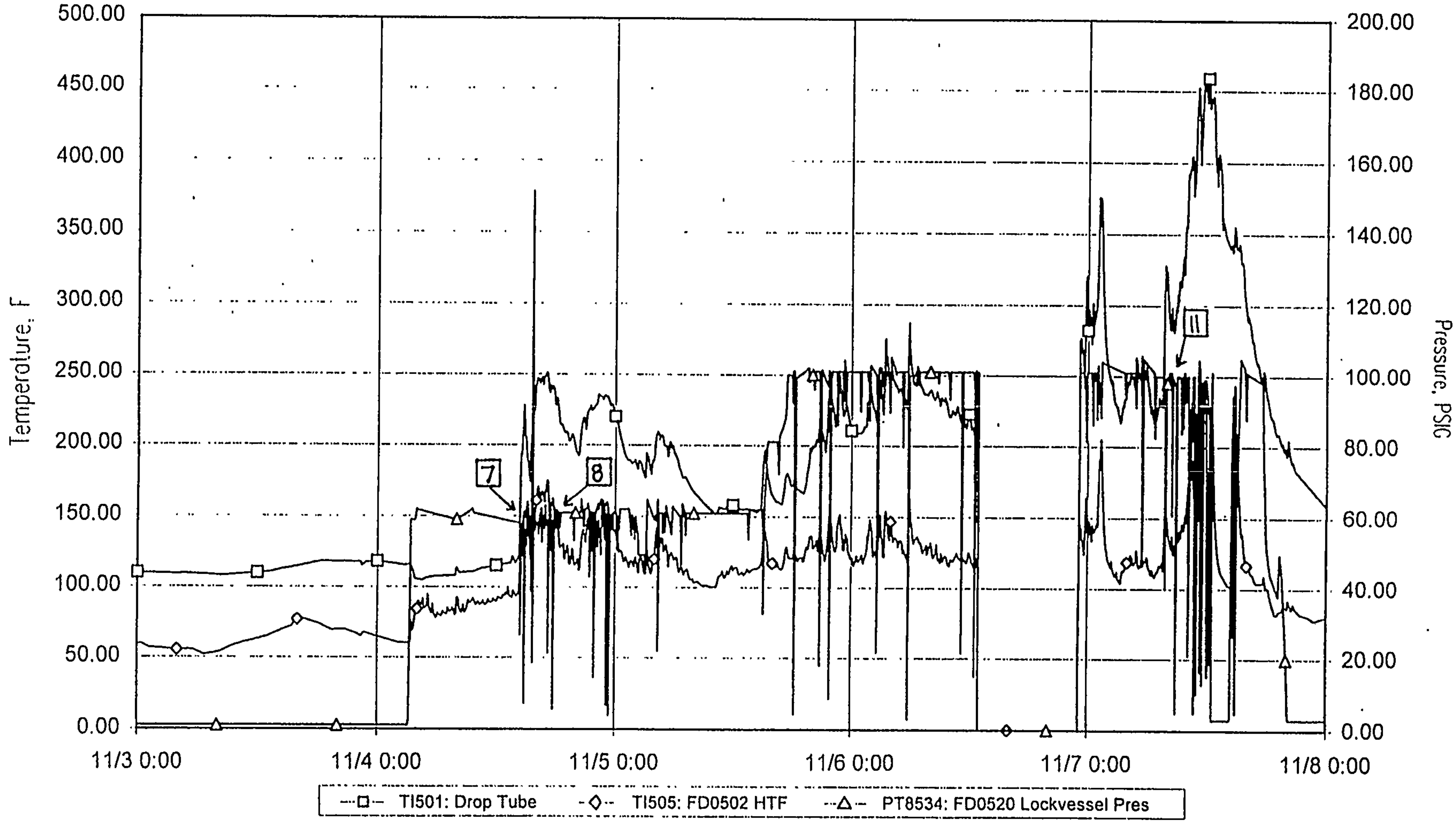
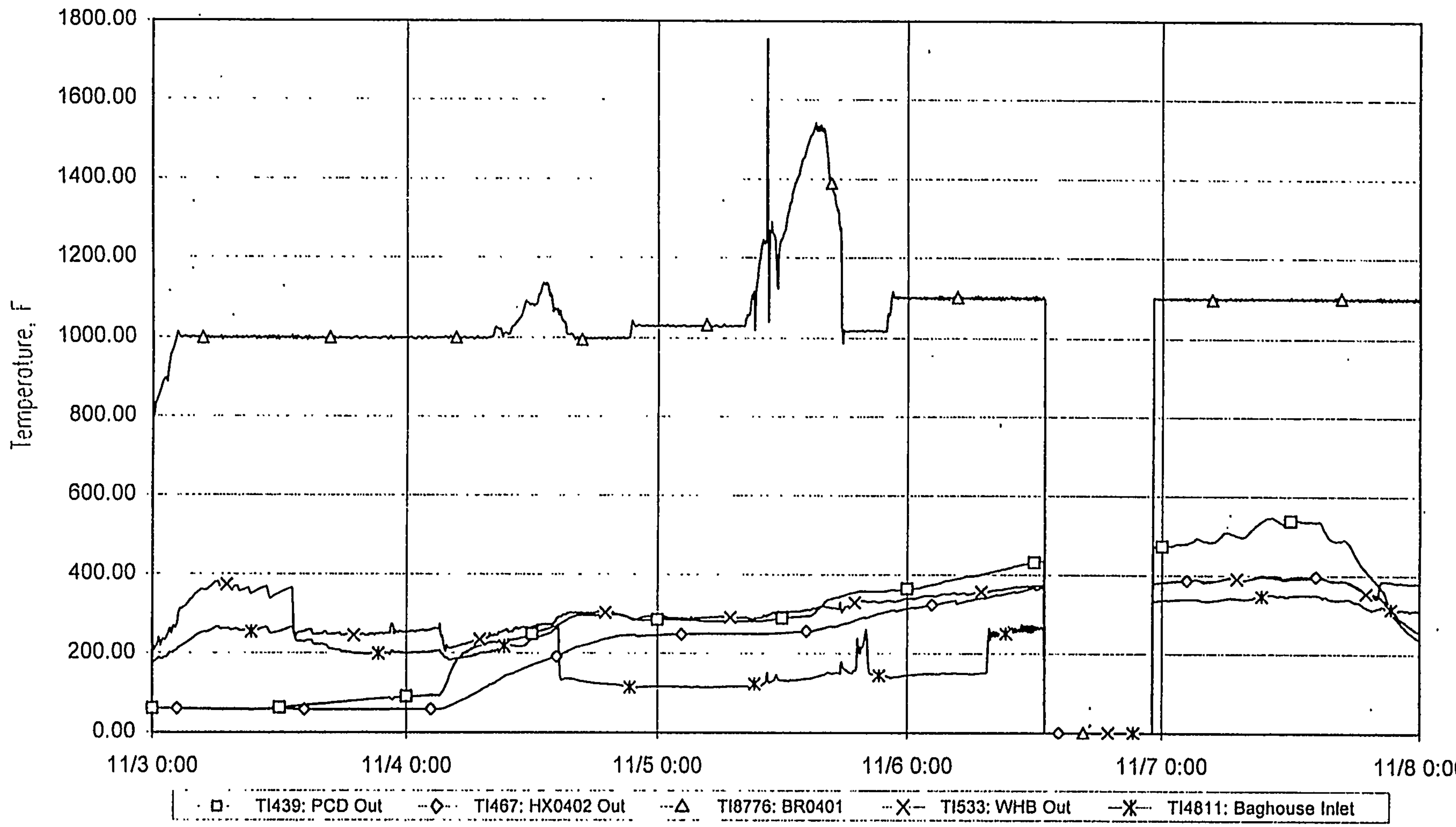


Figure 5.1.9-11 Temperature Profiles Downstream of Reactor for November 3 Through November 7, 1996



DOE Plot 18 of 45 - 5 minute data

Figure 5.1.9-12 PCD Ash Temperatures for November 3 Through November 7, 1996



DOE Plot 19 of 45 - 5 minute data

Figure 5.1.9-13 System Temperatures Downstream of PCD for November 3 Through November 7, 1996

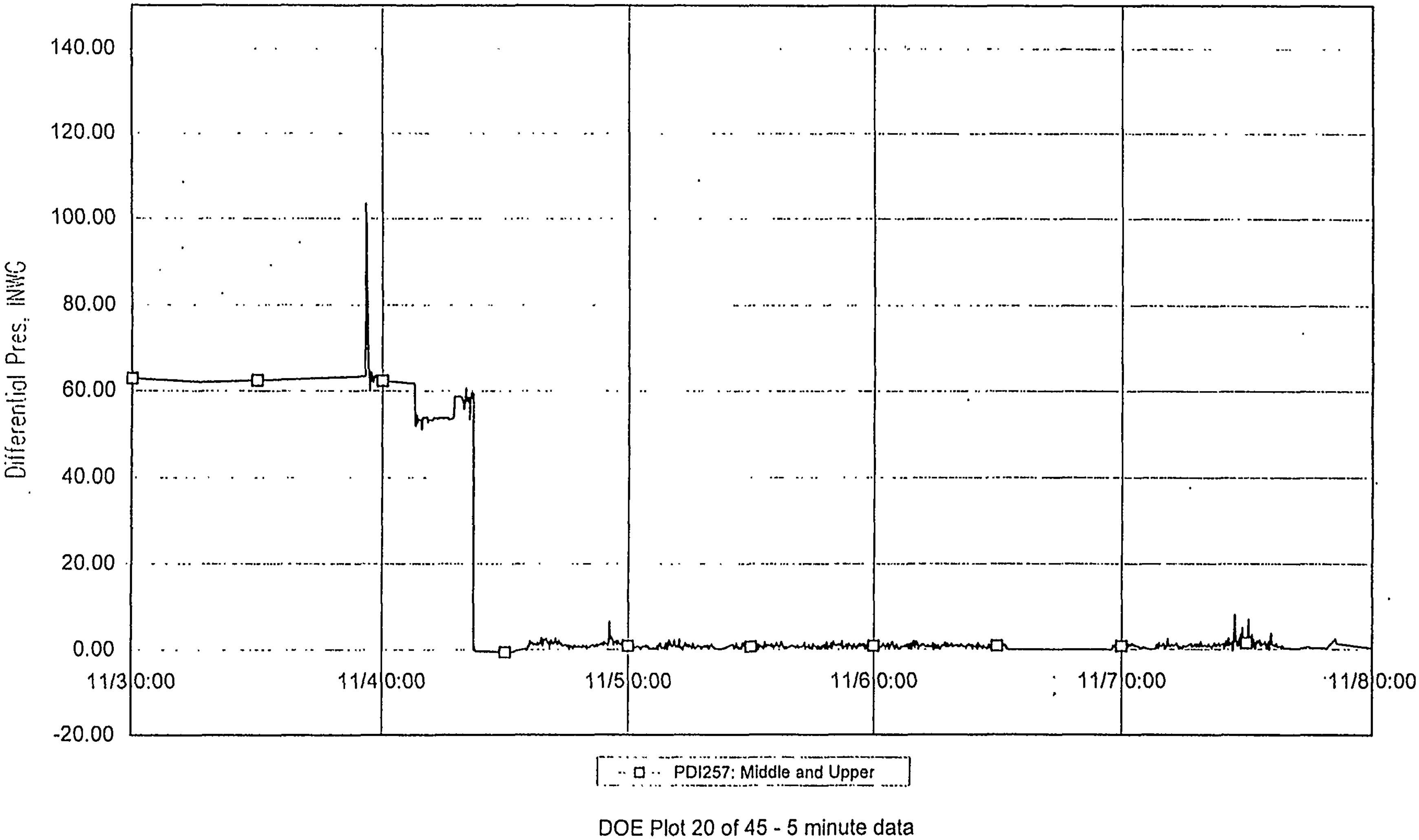
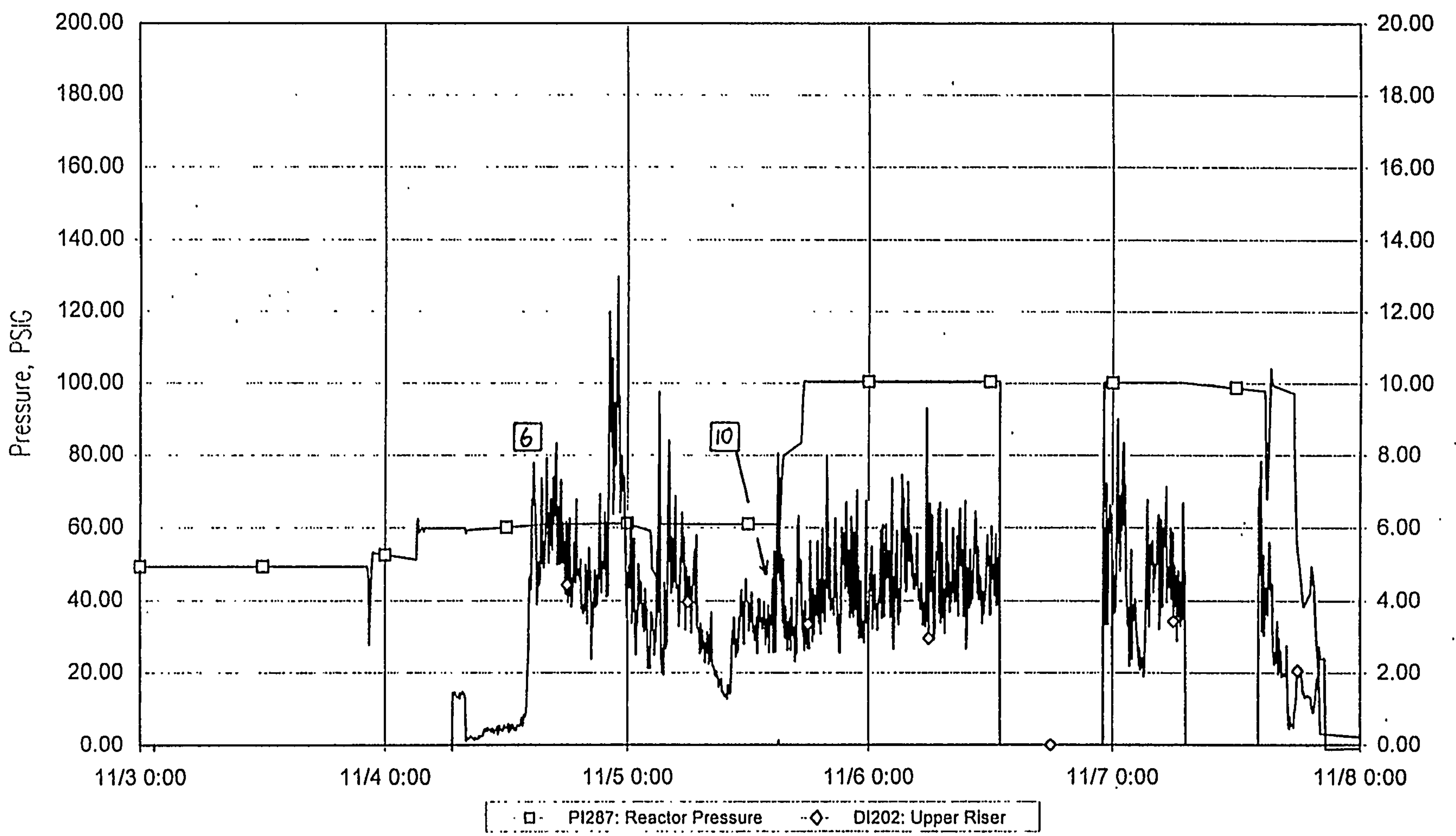
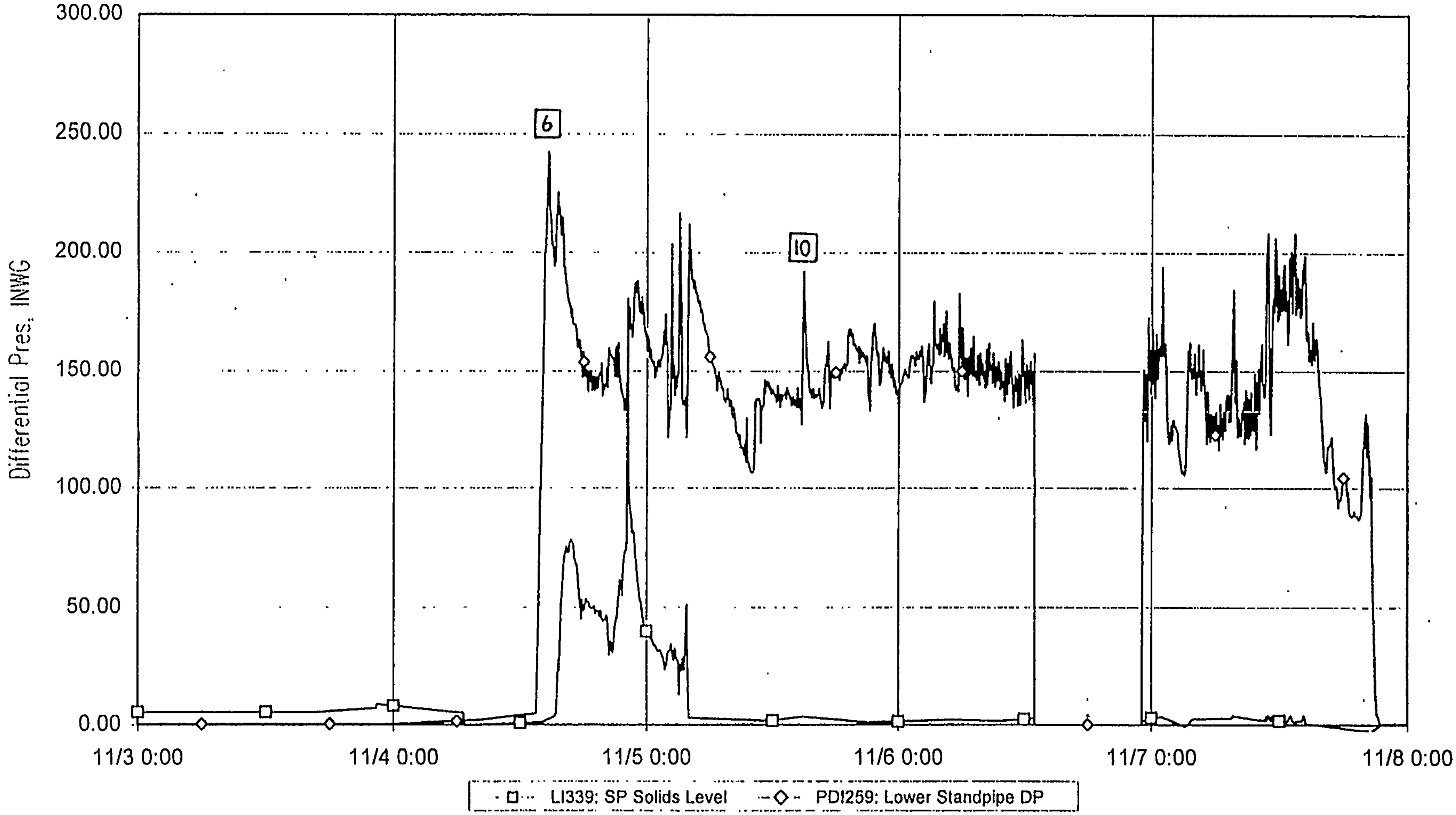


Figure 5.1.9-14 Mixing Zone DP Profile for November 3 Through November 7, 1996



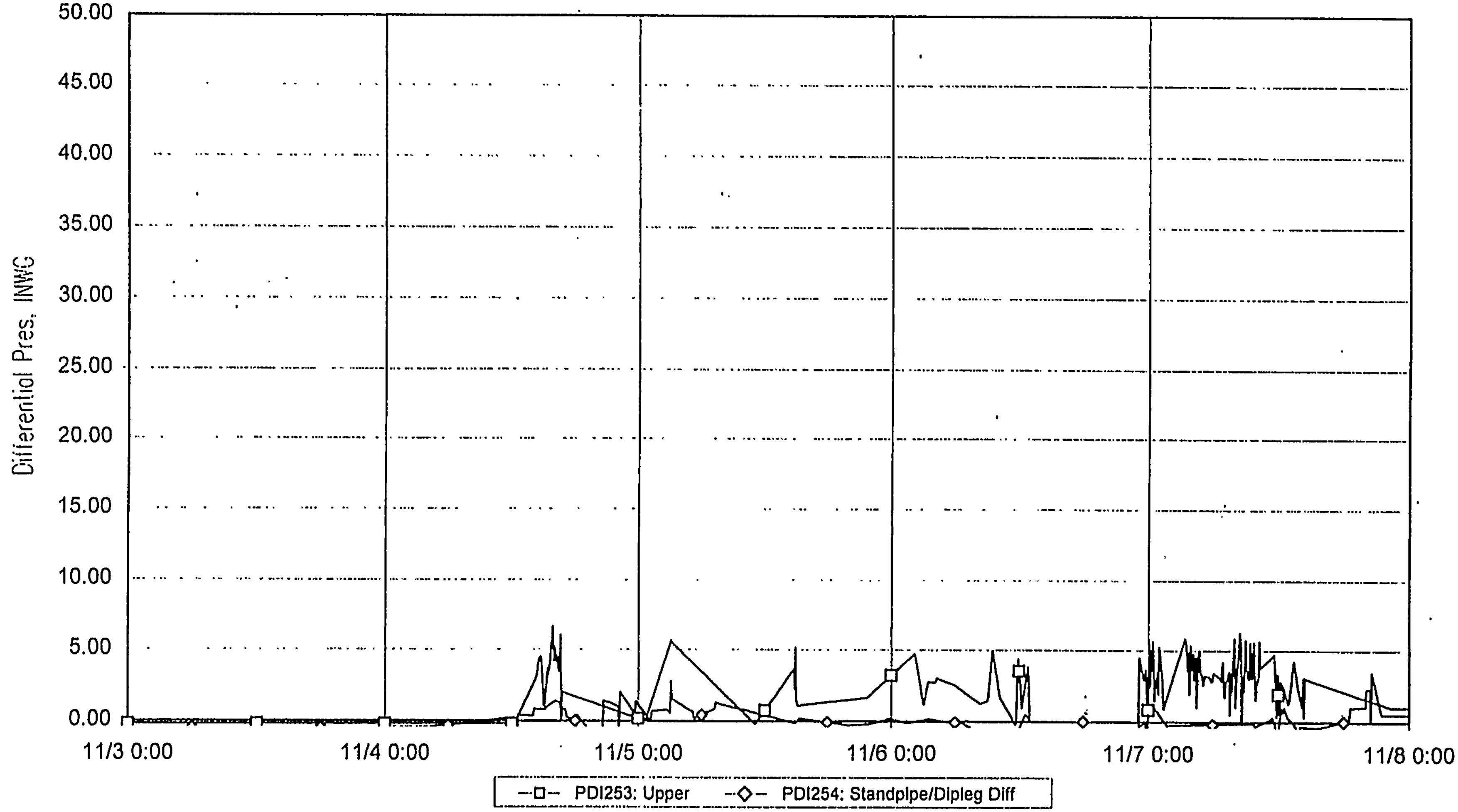
DOE Plot 21 of 45 - 5 minute data

Figure 5.1.9-15 Reactor Pressure/Riser DP Profiles for November 3 Through November 7, 1996



DOE Plot 22 of 45 - 5 minute data

Figure 5.1.9-16 Standpipe DP Profiles for November 3 Through November 7, 1996



DOE Plot 23 of 45 - 5 minute data

Figure 5.1.9-17 CY0201 Dipleg DP Profiles for November 3 Through November 7, 1996

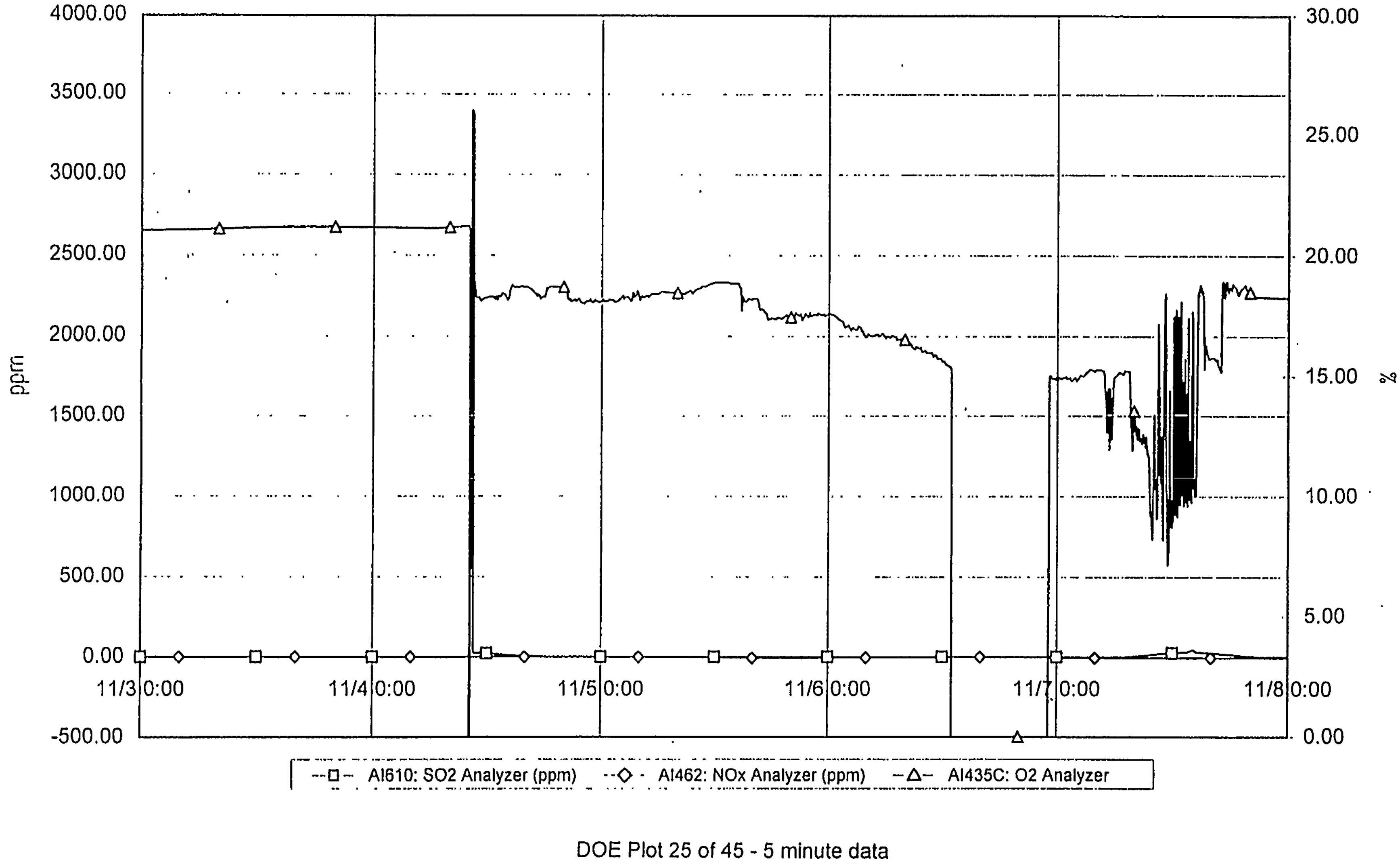
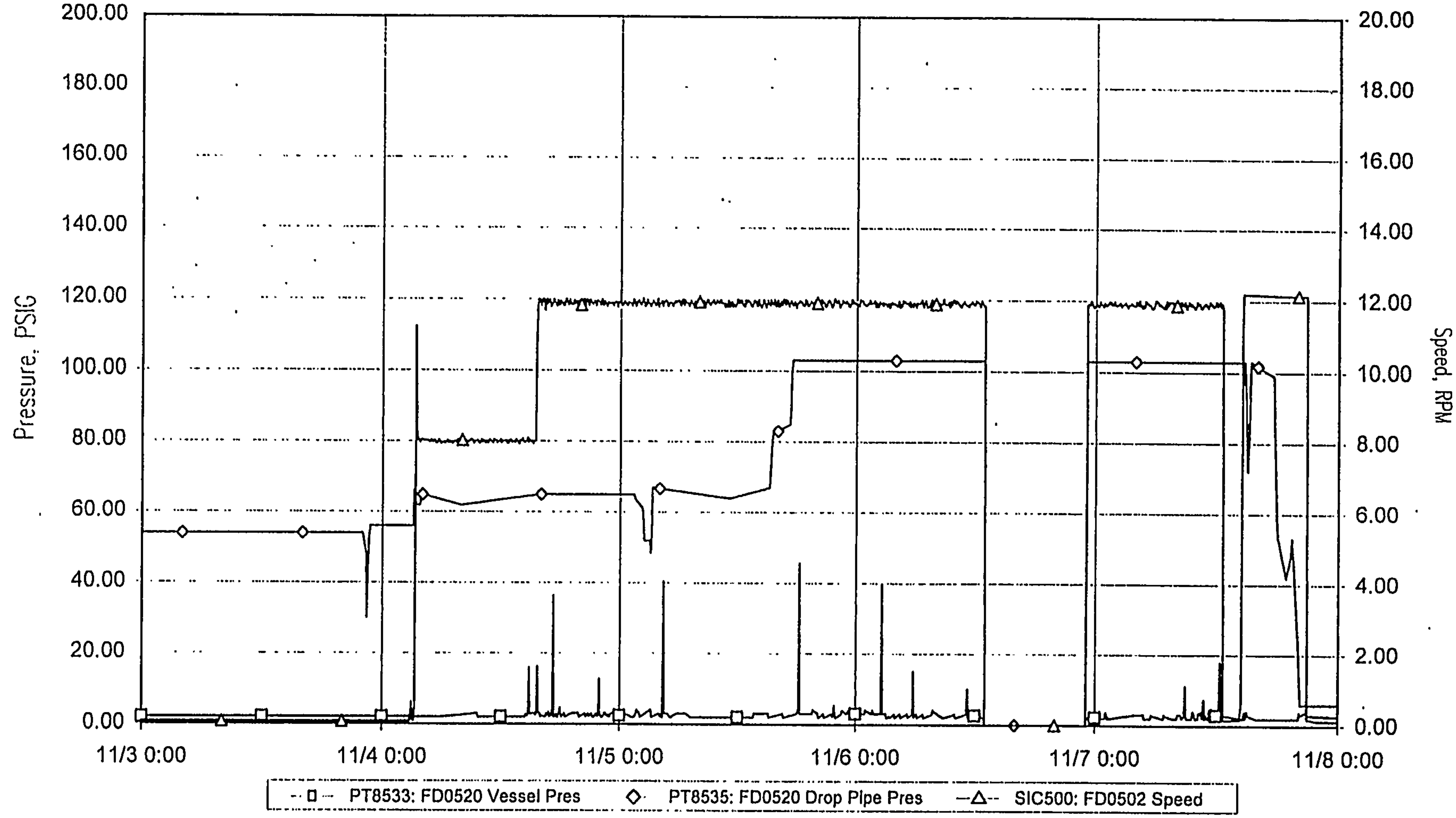
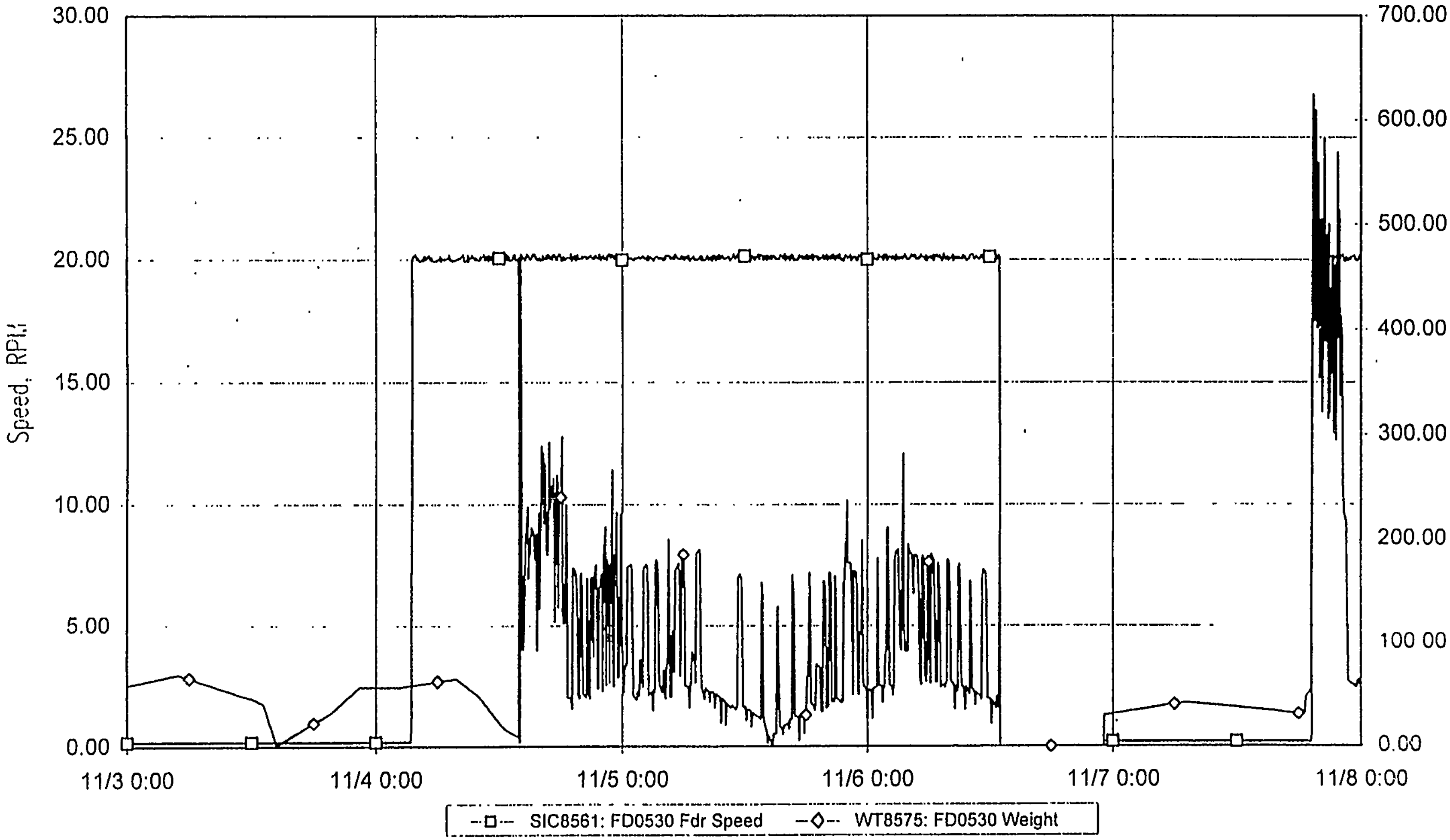


Figure 5.1.9-18 O_2, SO_2, and NO_X Analyzers for November 3 Through November 7, 1996



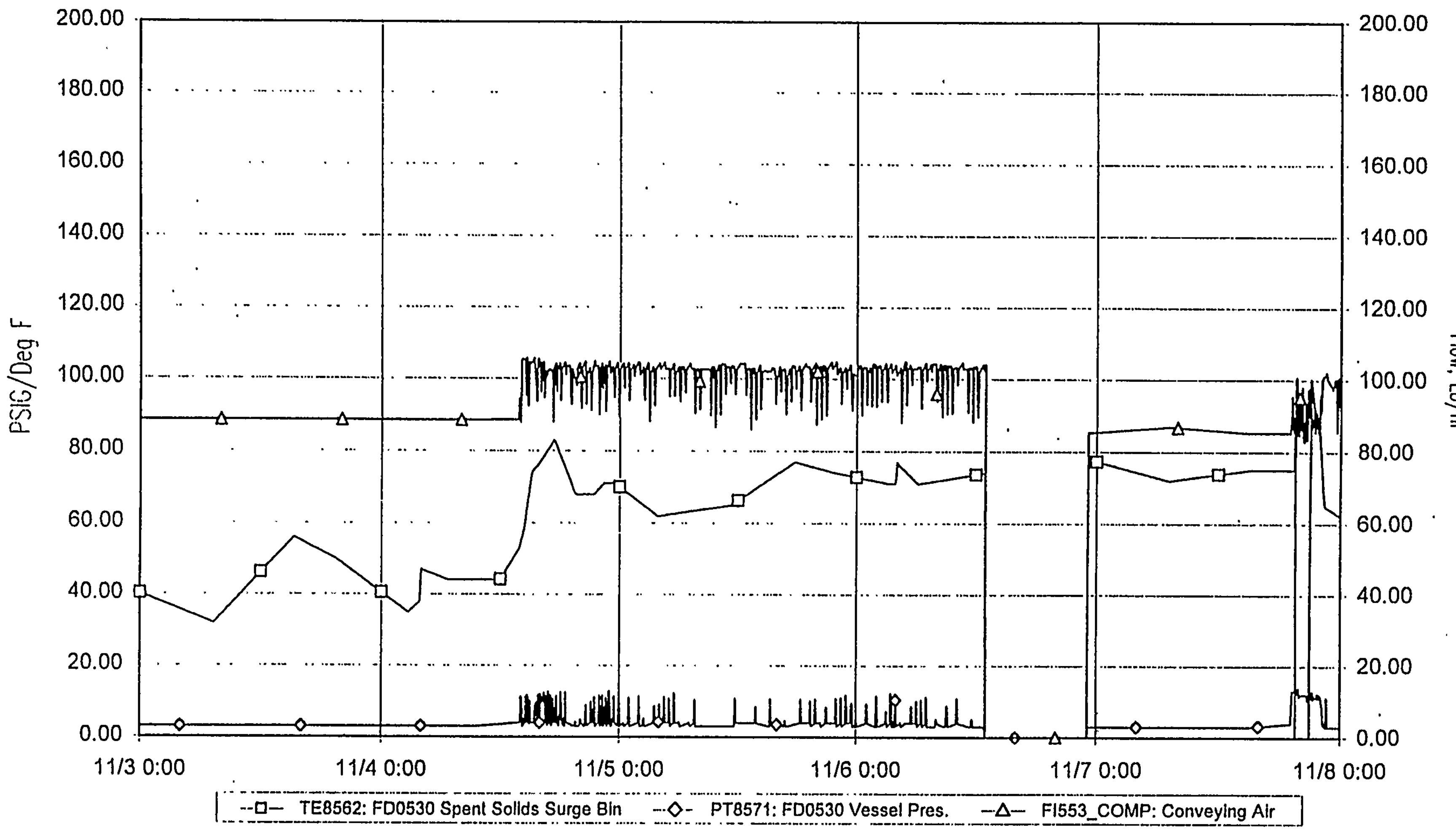
DOE Plot 32 of 45 - 5 minute data

Figure 5.1.9-19 FD0520 Pressures for November 3 Through November 7, 1996



DOE Plot 33 of 45 - 5 minute data

Figure 5.1.9-20 FD0530 Feeder for November 3 Through November 7, 1996



DOE Plot 34 of 45 - 5 minute data

Figure 5.1.9-21 FD0530 Feeder for November 3 Through November 7, 1996

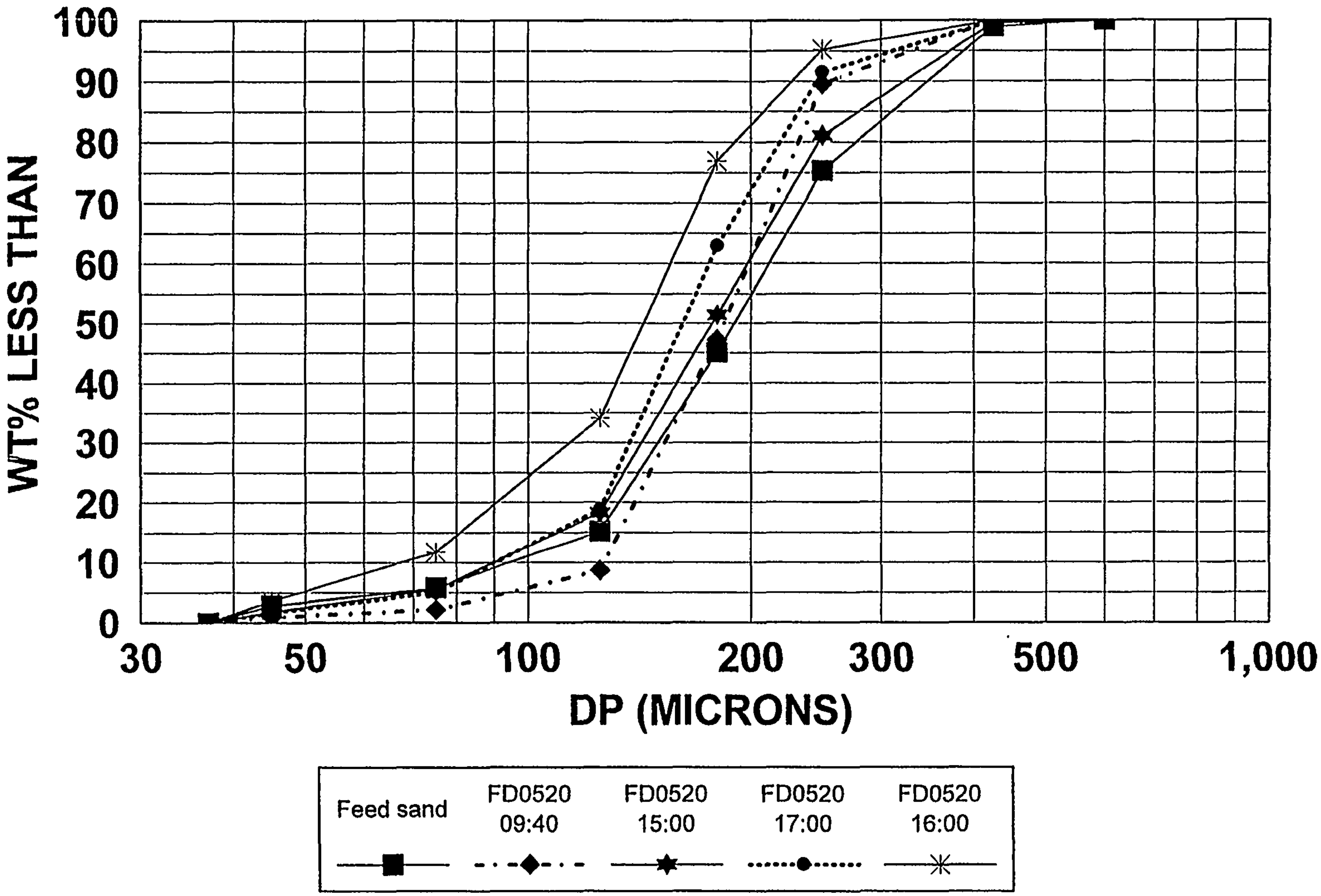


Figure 5.1.9-22 Feed Sand and PCD Solids Particle Size Distribution on November 4, 1996

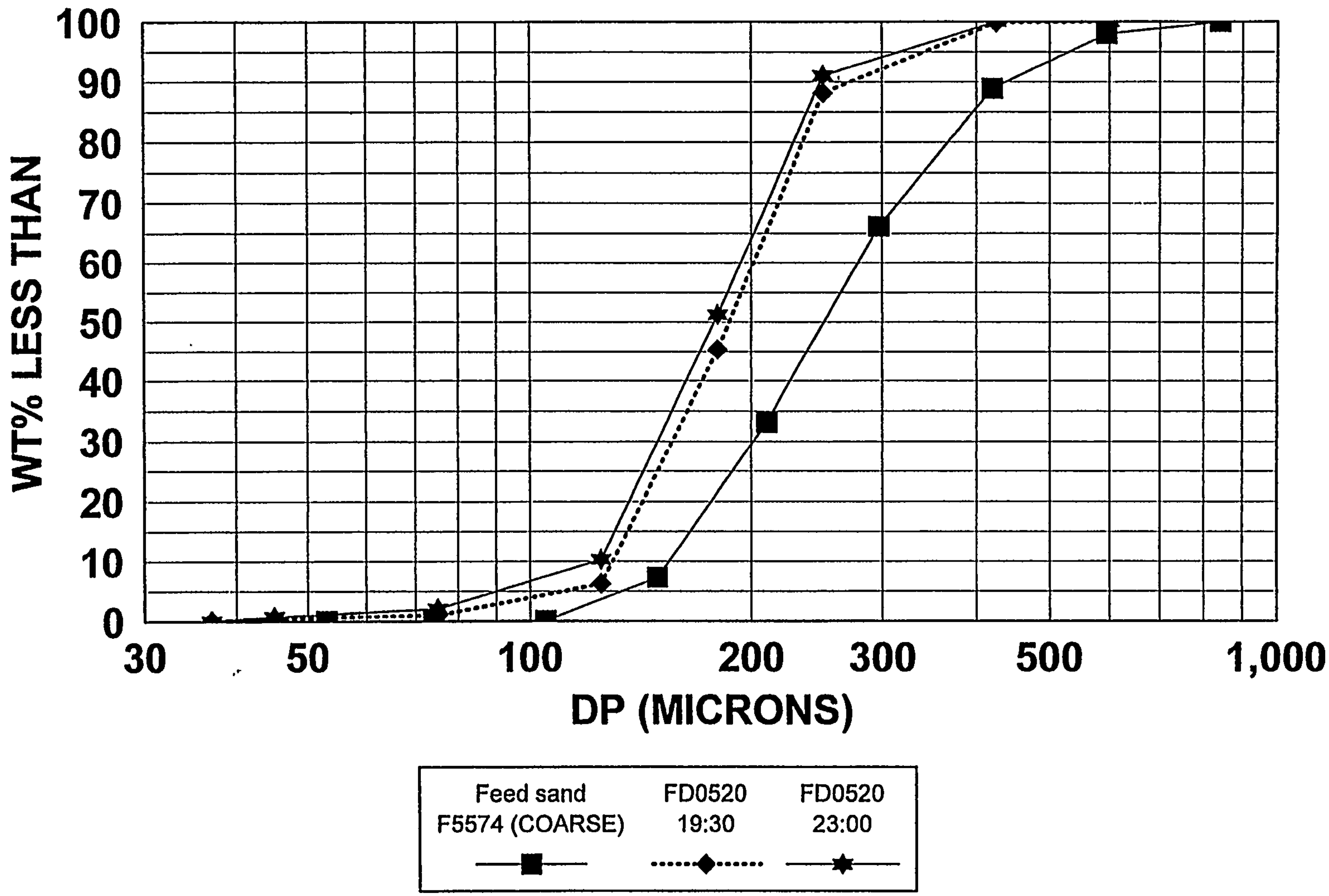


Figure 5.1.9-23 Feed Sand and PCD Solids Particle Size Distribution on November 4, 1996

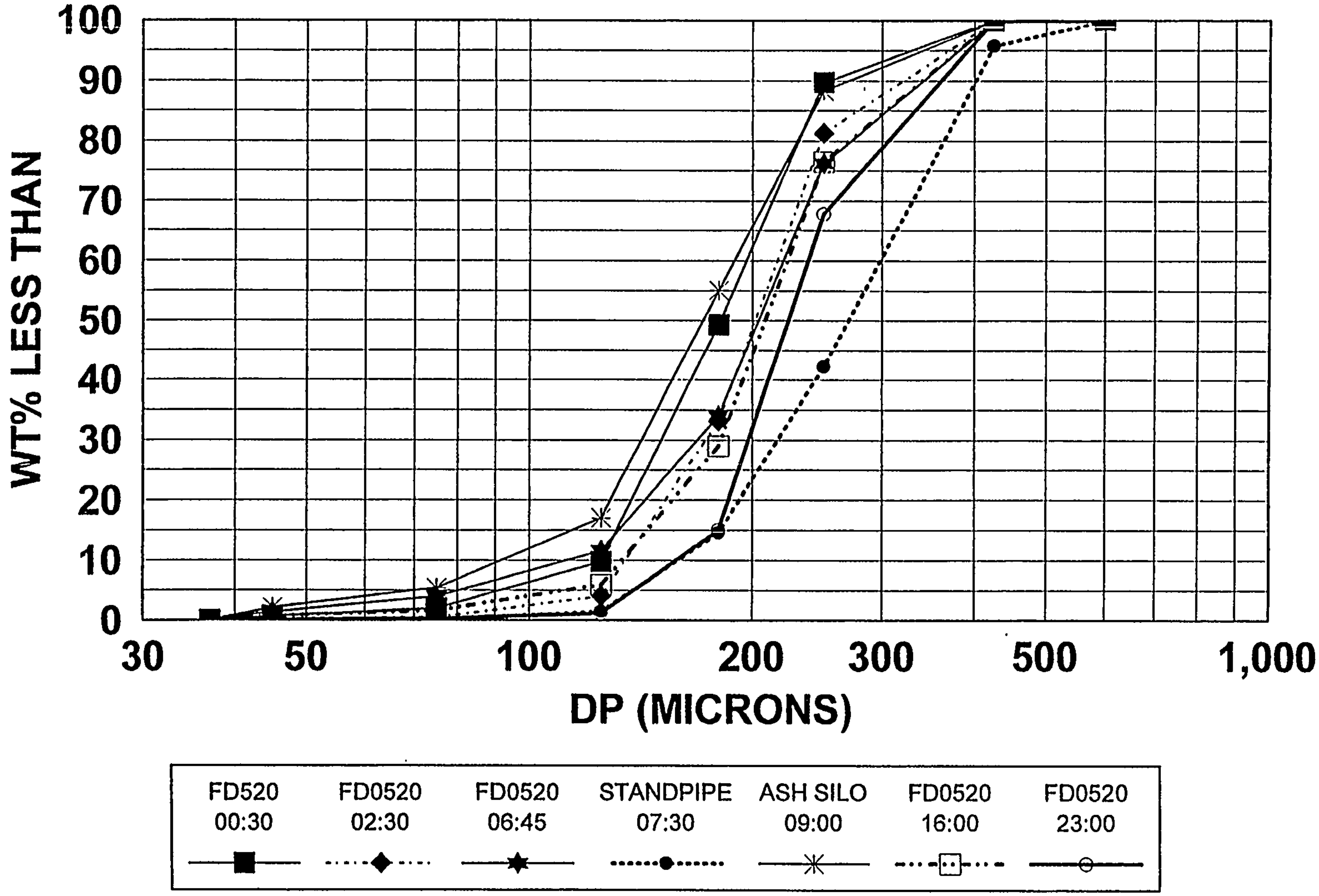


Figure 5.1.9-24 Standpipe and PCD Solids Particle Size Distribution on November 5, 1996

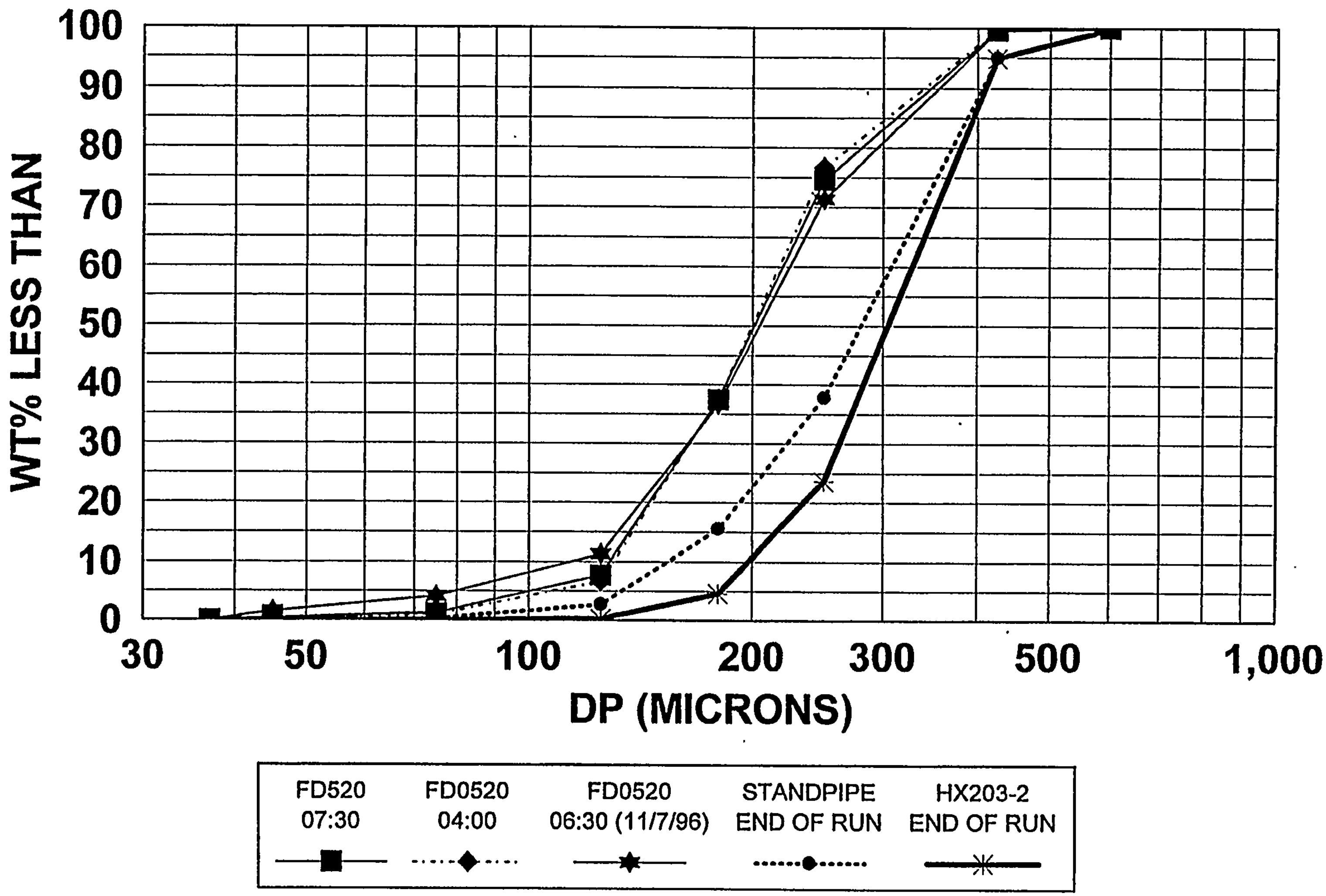


Figure 5.1.9-25 PCD Solids Particle Size Distribution on November 6 and November 7, 1996

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5.1.10 Characterization Test Run CCT2C

5.1.10.1 Introduction and Test Objective

This test run was a continuation of test runs CCT2A and CCT2B, as these test runs were terminated prematurely. The objective of CCT2C test run was the same as in the previous two test runs: characterization tests in combustion mode of operation with sand as the start-up inert bed material. The combustion characterization test run (CCT2C) was carried out between November 14 and November 22, 1996. Process raw data for this run are provided in figures 5.1.10-1 to 5.1.10-50. The figures provide trends for various tags in two time periods: November 14 to 17 and November 18 to 22.

5.1.10.2 Test Chronology

On November 13 start-up of the MWK transport reactor train was initiated. The thermal oxidizer was lit and fired to reach 150 psig steam drum pressure. The HTF system was started and the nitrogen system was lined up. The primary gas cooler (HX0202) was lined up to preheat the PCD. The main air compressor (CO0201) was started and the reactor was successfully leak tested to 300 psig. The Clyde systems were started and checked for their operations. In preparation for adding sand into the reactor, about two drums of sand were loaded into FD0140.

Preheating of the PCD continued on November 14. The reactor pressure was reduced to 60 psig and back-pulsing of the PCD was initiated. The spent solids screw cooler (FD0206) was run periodically to ensure that it was not plugged. The differential pressure indications were rebalanced and the corresponding instrument purges were set. The steam was lined up to the propane vaporizer. Around 08:30 the PCD outlet temperature (TI439) reached 200°F (event 1, figure 5.1.10-11). At 10:00 the start-up burner pilot was lit, but it tripped several times during the next 30 minutes. It appeared that the 1,250-scfh cooling purge flow to flame tip was high. It was determined that if the flame tip cooling purge flow is above 950 scfh the burner trips. Around noon, sand addition (~1,400 lb) to the reactor was started at 1.0-percent motor capacity (3.7 rpm). This sand came from draining almost two drums from HX0203 on November 11, 1996. As the aeration on the cyclone dipleg was turned on, cyclone dipleg temperatures (TI382, TI441, and TI442) started increasing. To confirm this, the aeration was turned off at 13:50, and the temperatures started decreasing. As the sand was added, the upper standpipe temperature (TI357) started increasing which showed hot sand (as it was being added) was coming down the disengager. At about 13:50 TI357 started decreasing, which indicates completion of the addition of sand through FD0210 (event 2, figure 5.1.10-9).

At around 14:05 more coarse sand (type T30/T50 from Badger Mining of Berlin, WI) was added to the reactor. The FD0210 tripped several times. Minimum aeration flows were set as sand was added to the reactor. All HX0203 J-leg aeration nozzles were plugged and had to be blown out. By 15:30 there had been 3,000 lb of sand loaded into the reactor. Another 3,000 lb of sand were transferred from FD0140 into FD0210.

At about 15:00 TI3001 and TI3002 (PCD cone temperatures) went up from about 110 to 200°F due to solids carryover. Even though TI501, TI505, and the FD0520 dumps showed no further carryover for the next 3 hours, the TI3001 and 3002 temperatures stayed up at around 200°F. TI505 appeared to have come down to where it was before carryover. TI501 had a new baseline temperature that was about 60°F higher than before carryover.

Initial attempts to light the burner at around 17:00 were unsuccessful due to a high pressure drop in the burner J-leg (>60 inH_20). Air flow through the burner J-leg was increased and the reactor pressure was decreased to lower the pressure drop. The main burner was then successfully lit at a burner J-leg differential pressure of about 35 inH_2O. The reactor pressure was then increased to 60 psig. About 40 minutes later the start-up burner tripped (probably due to a fluctuation in the propane flow at the vaporizer). The burner was successfully relit. Solids circulation in the reactor was established by adjusting the reactor J-leg aeration. The solid bed in the HX0203 was fluidized and the aeration in the HX0203 J-leg was slowly increased to initiate circulation through the heat exchanger. Throughout this test run, the solids circulation through the heat exchanger was poor due to bridging at the intersection of HX0203 standpipe and J-leg. The HX0203 standpipe and J-leg aeration flows and the bed fluidizing air flows were often adjusted to unbridge and induce circulation.

At 02:45 the FD0220 was started but it plugged in 5 minutes. The block valve to the reactor was closed, and the dispense vessel was depressurized. The reducing elbow from the feeder was rodded out through the bottom block valve. The dispense vessel was then repressurized, and air flowed through satisfactorily. The FD0220 feeder was started again at a very low speed (1 rpm) (event 3, figure 5.1.10-4). There continued to be some plugging problems in FD0220. At 06:33 the HX0203 boot and standpipe flows were reset to improve circulation through HX0203. Around 07:00 the start-up burner firing rate was lowered to reduce the HX0202 inlet temperature (~800°F) so that the downcomer could be cut-in (event 4, figures 5.1.10-5 and -8 to -11). Starting at 07:30 the downcomer was gradually cut-in and by 10:00, the HX0202 downcomer was fully opened and the blowdown was fully closed, placing the HX0202 in steam production mode.

The BR0201 firing rate was increased to raise the burner exit temperature to 1,475°F. At 10:15 solids addition from FD0210 was started. The initial weight was 3,300 lb. The FD0210 tripped twice during the loading so the feeder speed was increased. As solids were added, the standpipe level increased (event 5, figure 5.1.10-15). At 11:55 the ball valve was opened by SRI to collect a batch sample of particles. At 12:15 the 1-hour warming up of SRI sampling system was started. Fifteen minutes later, the FD0520 was forced to cycle and take a sample in order to compare with the SRI batch probe sample. From 13:20 to 13:40, SRI took the sample with their batch sampling probe.

At 13:45 the propane pressure at the trench was increased to 200 psig and subsequently the reactor pressure was increased from 65 to 80 psig with a corresponding increase in the pilot propane pressure. At 17:00 the reactor pressure was increased to 100 psig and the start-up burner pilot differential was set to 70 psig (event 6, figure 5.1.10-15). In order to better evaluate the flow of gases around the disengager, primary cyclone and its dipleg (PDT250 and PDT254) were taken out of service to repipe the transmitters. After establishing solids circulation through HX0203 by adjusting aeration flows and unbridging the solids near the bottom of the heat exchanger standpipe, the HX0203 J-leg aeration was reduced at 19:40 so that the circulation rate through the combustion heat exchanger would decrease and the reactor loop temperature could rise faster. Six drums of the coke breeze and PRB coal mixture (3-to-1 weight ratio) were added to FD0140 bin for transfer to FD0220. The total amount of coal and coke breeze mixture transferred to FD0220 was 1,750 lb.

At 20:40 FD0220 was started and the feeder speed was gradually increased to 6.0 percent over the next hour (event 7, figure 5.1.10-4). At 23:20 the start-up burner tripped, and was relit. By 23:21 the pilot and main burner were lit. At 23:38 the start-up burner and the reactor system tripped. The root cause seemed to be CO0201, which unloaded and tripped everything in the reactor loop. The alarms were reset and the compressor was loaded (event 8, figures 5.1.10-1, -5, -7 to -11, -15, and -19).

The pilot and main burner were relit around midnight on November 16. The main air compressor continued to have control problems so it was placed in the manual position. After establishing all the aeration flows and solids circulation, a coal and coke breeze mixture feed to the reactor was started at 01:17 using FD0220 at 1.11 rpm (3.0 percent). From 01:38 to 02:44 the FD0220 feeder speed was increased from 4.0 to 8.0 percent (1.68 rpm) in steps of 1.0 percent. The FD0220 feeder speed was further gradually increased to 15 percent (2.45 rpm). Coke/coal mixture feed continued through FD0220 at the same rate to bring up reactor temperature (event 9, figure 5.1.10-4). At 07:15 the start-up burner temperature was at 1,950°F. The differential pressure across CY0201 was slightly higher than across CY0207. Total gas flow rate in and out of the reactor was about 16,200 lb/hr. The mixing zone temperatures varied from 1,120 to 1,220°F, the riser temperatures were around 1,220°F, the standpipe temperatures varied from 1,070 to 1,170°F, and the cyclone dipleg temperatures were between 900 and 1,000°F. The PCD gas inlet and outlet temperatures were between 500 and 550°F. Figure 5.1.10-8 shows the reactor mixing zone and riser temperatures, figure 5.1.10-9 shows the standpipe temperatures, figure 5.1.10-10 shows the dipleg temperatures, and figure 5.1.10-11 shows the cyclone exit and PCD temperatures during this time.

At 07:20 about 1,000 lb of sand in FD0210 was fed into the reactor to build level in the reactor standpipe. Figure 5.1.10-3 shows the FD0210 storage weight and the feeder speed. At 09:15 the average coke/coal feed rate was 126 lb/hr. The riser temperatures were close to 1,300°F. FD0220 feeder speed was increased from 2.45 to 3.0 rpm. Solids from HX0203 were periodically circulated to make up for the level in the reactor standpipe. At

10:00 HX0203 circulation was initiated for a short period by increasing the boot, standpipe, and J-leg aeration. Solids from HX0203 are used to increase the level in standpipe, typically from 110 to 160 inWG on PDT259. Circulating cold solids from HX0203 caused the reactor temperatures to drop by ~100°F (event 10, figures 5.1.10-8 and -16). The feed rate from FD0220 was further increased gradually to 3.49 rpm giving a coke/coal mixture feed rate of about 160 lb/hr.

About 14:00 the FD0220 feeder speed was increased to 5.51 rpm. Even though the mixing zone temperatures were around 1,250°F and the top of the riser temperatures were around 1,370°F, the temperature rise was slow since most of the coal/coke breeze mixture that was fed was being carried out to PCD. Also, the circulation through the reactor J-leg slowed down due to a decrease in the standpipe level.

The riser temperature continued to increase gradually. At 16:30 when the riser temperature was about 1,450°F, the FD0220 feed was reduced from 5.51 to 5.25 rpm due to excessive carryover to the PCD (~8 FD0520 dumps/hr). The riser temperature decreased by about 15°F and PDT259 steadied around 135 inWG. The FD0502 speed was increased from its nominal operating maximum of 8.2 rpm to 12.17 rpm to observe operations at higher speeds. This increase revealed that the speed indication on the PI system was smoother at 12.17 rpm. The higher speed also increased the fines removal capacity.

At 18:00 the burner exit temperature was 1,994°F, and since the reactor temperatures could be maintained through coal/coke breeze mixture combustion, the start-up burner firing rate was reduced (event 11, figure 5.1.10-5). The FD0220 (set at 5.3 rpm) was feeding about 167 lb/hr based on the FD0220 weigh cells.

At 19:10 the FD0220 feed rate was increased to 40 percent, and the riser temperature was around 1,550°F. At 20:00 there were indications that combustion was occurring in the cyclone dipleg by TE441 climbing to 1,650°F (event 12, figure 5.1.10-10) due to lower mixing zone temperatures. The coal feed rate and the solid circulation rates were reduced. Also at 21:00, the flow rate on one of the aeration nozzles in the dipleg (FI811) was fully opened.

At 21:15 the start-up burner firing was increased in an attempt to restrict the coal/coke breeze combustion to within the reactor instead of the cyclone dipleg. Also, the FD0220 speed was reduced to 37 percent. At 22:00 the compressor surged, which caused the burner to trip and shut down. The start-up burner pilot and main burner were relit. The riser temperatures dropped from about 1,500 to 1,000°F (event 13, figures 5.1.10-5, -8 to -11, and -19).

On November 17 at 00:36 when the mixing zone temperatures reached about 1,200°F, coal feeding resumed with the feeder speed set at 5.0 percent. The FD0220 speed was gradually increased to about 38 percent. After-burning again occurred in the cyclone dipleg. At 03:00 three drums (960 lb) of Calumet mine bituminous coal were transferred from FD0140 to FD0220. The FD0520 was forced to cycle in order to test whether the Spheri valve was functioning since FD0520 had not dumped for a long period of time due either to problems with FD0520 or very little carryover of solids to PCD. The FD0520 functioned normally.

At 07:14 the start-up burner tripped. The propane vaporizer was suspected of causing a fluctuation in the propane flow. At 07:30 the burner was relit after the J-legs aeration rates were reduced in order to increase the burner quench flow and blow the solids from the burner J-leg. This reduced the differential pressure across the burner J-leg. Since the solids circulation through the HX0203 continued to be a problem, the fluidization velocity in the heat exchanger was increased by increasing FIC230. This was done to determine if expanding the bed of solids in the heat exchanger would provide better control of circulation of solids through the heat exchanger. The bed expanded and with an increase in HX0203 J-leg aeration, the solids circulation through HX0203 J-leg was established. The reactor standpipe level as measured by PDT259 also increased to 160 inH_2O (event 14, figure 5.1.10-16). Two drums of T30/50 sand were transferred from FD0140 into FD0210 for reactor level makeup.

At 11:10 with the mixing zone temperatures above 1,200°F, the coal feed was started from FD0220 at 1 rpm and increased to 6 rpm over the next 2.5 hours. At 13:45 the standpipe level was again increased from 130 to 155 inWG (PDT259) by establishing circulation through the HX0203 J-leg for a short period of time. At 14:50 the coal feed rate was further increased to 7.5 rpm (event 15, figure 5.1.10-4).

Based on solids loss calculations, about 250 to 300 lb/hr were lost from the reactor (solids addition, standpipe level changes, and heat exchanger level changes) over the previous 24 hours (excluding trips). The number of dumps to the PCD while feeding coal was about 8 to 10 per hour. The density of the PCD carbonaceous ash was about 30 lb/ft^3. The FD0530 weigh cells show that each FD0520 dump was about 15 to 25 lb. It is possible that the FD0520 lockhopper vessel may have had solids sticking to the wall of the vessel, which would reduce the amount removed through FD0520. Also, solids from FD0520 dispense vessel appeared to be moving to FD0530 surge bin much faster, due either to the material being lighter or less amount of material per dump. It was later determined that the fines from the PCD were sticking to the sides of the FD0520 lockhopper and thereby transferring a much smaller amount-per-dump.

At 15:10 the FD0220 speed was increased to 8 rpm. The burner firing was decreased since the riser velocities were high (42 to 48 ft/sec). The propane flow rate was maintained at about 195 lb/hr and the burner exit temperature around 1,925°F. The FD0220 feeder speed was increased from 8 rpm (63 percent) in steps of 0.2 rpm to maintain the riser exit temperature between 1,575 and 1,600°F. At 15:55 five barrels (1,600 lb) of bituminous coal were transferred into FD0220.

At 16:05, FV364 was set to 65 percent with FI364 around 163 lb/hr. While waiting on the reactor to equilibrate, the riser temperatures started to increase rapidly. The burner outlet temperature was decreased even further to 1,670°F. The temperature was still increasing so the coal feed was gradually reduced from 67 to 64 percent (8.1 rpm). PDT259 was steady at 145 inWG. At 17:55 five drums of coal were transferred to FD0220 from FD0140.

Around 18:00, since the coal feeder (FD0220) tripped a couple of times, the burner firing rate was increased (event 16, figures 5.1.10-4 and -5). At 18:20 sand addition to reactor was started from FD0210, but the FD0210 feeder kept tripping. At 18:30 FD0520 was investigated and it was found that gas was continuously leaking through the vent valve XV8539 (a ball valve). This could have been the source of premature level indication in FD0520 and also the cause for the 5- to 10-inch differential pressure on the FD0530 vent filters. By 18:40 all sand had been fed from FD0210 to the reactor so that FD0210 could be used as a backup to FD0220.

At 19:40 1,143 lb of coal were transferred to FD0210 due to the problems with FD0220. At 20:00 start-up burner firing was decreased. At 21:15 the start-up burner tripped probably due to a fluctuation in propane flow. Because the temperatures in the reactor could be maintained with coal combustion, the burner was not relit (event 17, figure 5.1.10-5). The HX0203 boot and standpipe aeration was pulsed and adjusted to initiate solids circulation. The reactor pressure was gradually increased in small steps from 100 psig at 21:30 to 180 psig at 09:00 on November 18 and then reduced back to 160 psig. The process was operated at 160 psig for the remainder of the test run. The instrument purge flows were set to 160 psig operation (event 18, figures 5.1.10-15 and -40).

The FD0220 feeder speed was set to 100 percent. The corresponding coal feed rate was about 400 lb/hr. As FD0220 surge bin was being emptied, about 3,000 lb of coal were transferred from FD0104 into FD0210, and at about 23:00 coal feed resumed from FD0210. The estimated coal feed rate was about 520 lb/hr. As reactor temperatures continued to increase, coal was fed in batch mode from FD0210.

At 01:05 on November 18 about 3,120 lb of sand were loaded to FD0220. The sand was fed from FD0220 until about 07:30. During this time period, the standpipe differential pressure (PDT259) increased from 130 to 190 inH_2O (event 19, figures 5.1.10-29 and -41). As the level in standpipe increased the circulation rate and carryover to PCD also increased. The coal feed rate during this time period ranged from 490 to 720 lb/hr.

At 08:50 sand feed resumed from FD0220 and continued until about 14:00. The HX0203 J-leg aeration rate was reduced to decrease the solids carryover to PCD while troubleshooting was taking place on problems associated with the transport air dryer. At 11:20 the main air compressor was put back in the automatic position. At 14:15 PDT250 and PDT254 were repiped and reconnected so that PDT250 read pressure loss across

CY207 hopper, and PDT254 measured the differential between the standpipe and cyclone dipleg. At 14:30 the reactor standpipe aerations were pulsed and set to specified values.

After all the sand in the bin was fed, coal was added to FD0220. Coal was fed from FD0220 whenever problems developed with FD0210 or when the feed rate from FD0210 was too high and could not be adjusted to control the reactor temperature. Between 18:00 and 23:00, the coal feed rate varied from about 650 to 730 lb/hr. Since the standpipe level was low (about 120 inWG as measured by PDT259), about 3,000 lb of sand were added through FD0220 between 01:00 and 05:00 on November 19 (event 20, figures 5.1.10-29 and -41). Continuous coal feed was maintained with FD0210 at coal feed rates ranging from 590 to 720 lb/hr.

The coal feed was switched from FD0210 to FD0220 a few times due to FD0210 tripping (because of lock vessel top Spheri valve fail to close alarm). Also, coal was batch fed from FD0210 since the reactor temperature was too high with the feeder set at the minimum speed. At 12:20 the coal feeder speed was changed for a better turndown enabling coal to be fed continuously from FD0210. Between 11:30 and 15:00 about 3,000 lb of sand were added using FD0220. However, most of it seemed to escape into the PCD because there was little accumulation in the standpipe and HX0203.

By 14:20 about 29,000 lb (14.5 tons) of coal had been fed into reactor. The coal feed rate was about 575 lb/hr which was close to the value calculated based on CO_2 (event 21, figure 5.1.10-43). Intermittent sand addition to the reactor from FD0220 was resumed at about 17:30. The skin temperature differentials calculated using the midnight readings were as follows: 22°F between riser/mixing zone and standpipe, 5°F between standpipe and cyclone dipleg, 90°F between standpipe and HX0203, and 112°F between riser/mixing zone and HX0203.

The mixing zone, riser, and standpipe temperatures were quite stable after 12:00 on November 19. Stable reactor temperatures and standpipe solids level continued onto November 20. No sand was fed between 03:00 and 14:00. At 11:00 the reactor temperatures started decreasing and the excess oxygen began increasing because the coal feeder speed dropped due to unknown reason. The feeder speed was increased (from 1.0 to 1.5 percent of motor capacity) which resulted in higher stable reactor temperatures (from 1,534 to 1,584°F highest temperature in the riser) with decreased excess oxygen level in the gas.

The product gas analysis was as follows: SO_2 concentration = 123 ppmv, O_2 = 14.14 percent, CO = 0.0015 percent, and CO_2 = 5.23 percent. The coal feed rate was about 578 lb/hr. All staging air nozzles were fully open. Approximately 2,080 lb/hr air flow was flowing through the three-staged air nozzles. At 11:40 the riser crossover was blown for 5 minutes by increasing the third-stage air flow. It did not appear that a significant amount of "salted" material (if any) was being blown from the crossover into the standpipe. The flows were reset to the prior values after the test.

Between 14:20 and 17:00 1,380 lb of sand (T30/T50 type) were added to the reactor. At 15:50 cyclone spoiling tests were started by setting FIC444. The FIC444 was increased and then decreased from zero to 1,500 lb/hr in increments of 500 lb/hr to see what the effect would be on cyclone performance. No noticeable change in cyclone performance was observed. With the reactor operations stable, the coal feed rate was slowly increased from about 1.0 to 2.1 percent (3.1 to 3.6 rpm) of feeder motor capacity by 22:30.

The reactor inventory levels were self-sustaining with the ash generated in the process even with the higher coal feed rate. At 06:00 on November 21 the coal feed rate was reduced from 2.1 to 1.3 percent to reduce the maximum reactor temperature from 1,670 to 1,600°F. At 07:55, since sand was not being used to makeup for the reactor level, 1,540 lb of sand were drummed out of FD0220 and 500 lb of dolomite were transferred into FD0220. At 08:23 FD0220 was started, but dolomite addition into the reactor did not actually occur until 08:40 because some sand was left in the dispense vessel. Dolomite addition was indicated when the SO_2 level in the gas stream dropped from about 110 to 46 ppmv (event 22, figures 5.1.10-29 and -44). The coal feed rate was about 600 lb/hr and the estimated dolomite feed rate was 600 lb/hr. By 09:00 the SO_2 concentration had dropped to 25 ppm. The FD0220 feeder speed was reduced from 2.5 to 1.2 rpm, and another 500 lb of dolomite were transferred into FD0220. Total coal fed up to 08:45 on November 21 was about 22 tons.

At 09:50 SRI started sampling the inlet to PCD. At 10:00 the sorbent feed rate was estimated at 200 lb/hr with feeder at 1.2 rpm. By 10:25 SRI had finished collecting the sample. The desulfurization rate was estimated as 93 percent at an SO_2 concentration of 16 ppmv. The dolomite feed was stopped to determine the system response by monitoring SO_2 emission. By 11:10 SO_2 concentration increased from 16 to 25 ppm, and by 11:25 SO_2 concentration increased to 47 ppm (event 23, figures 5.1.10-29 and -44). Dolomite feeding at that time was then resumed at 0.7 rpm.

At 11:28 the FD0220 speed was set to 0.9 rpm which is equivalent to a Ca/S molar ratio of 3/1. From cyclone dipleg temperatures, it appeared that the cyclone operations were smoother with dolomite addition to the reactor (event 24, figure 5.1.10-35). At 12:20 FD0220 was increased to 1.2 rpm to increase dolomite feed rate back to 200 lb/hr, so that FD0220 could be emptied to feed sand into the reactor to bring up the solids level in the reactor.

Starting at 13:30 about 300 lb of sand were fed into the reactor, and the standpipe level increased from about 99 to 117 inWG. An additional 1,600 lb of sand was added into the reactor. At 18:25, 650 lb of dolomite were added into FD0220. The coal feeder speed was gradually increased from 1.8 to 3.0 percent over the next 3.5 hours (event 25, figure 5.1.10-28). At 19:35, dolomite feed was started at 10-percent motor output (1.9 rpm) of FD0220 (event 26, figures 5.1.10-29 and -44). The SO_2 composition (according to the analyser) dropped from about 130 to 20 ppm. At 20:45 FD0220 speed was reduced to 1.7 rpm, and an additional 566 lb of dolomite were transferred into FD0220.

At 21:48 FD0210 tripped due to a lock vessel Spheri valve failure. The feeder was restarted.

Again, around 23:57 FD0210 tripped three times: once because the lock vessel spherical valve failed to close and another time because the vessel failed to pressurize. Very little coal was flowing through the FD0210 storage bin to the lock vessel even though the gate valve at the bottom of the bin was fully opened. Five drums of coal were drummed out of FD0210 to transfer coal to FD0220. The coal feed rate was reduced to 2.1 percent motor output, because the feeder was having problems. The FD0210 tripped at 00:52 because the lock vessel failed to pressurize. Between 01:10 and 01:28, FD0210 tripped three times because the lock vessel Spheri valve failed to close. At 01:36 FD0210 was shut down due to operational problems and FD0220 was started (event 27, figure 5.1.10-28). The FD0220 was used to maintain the reactor temperature while troubleshooting was taking place on FD0210. There were also problems with fluctuations in the main air compressor flow, and as a result, the air compressor was put in manual control position.

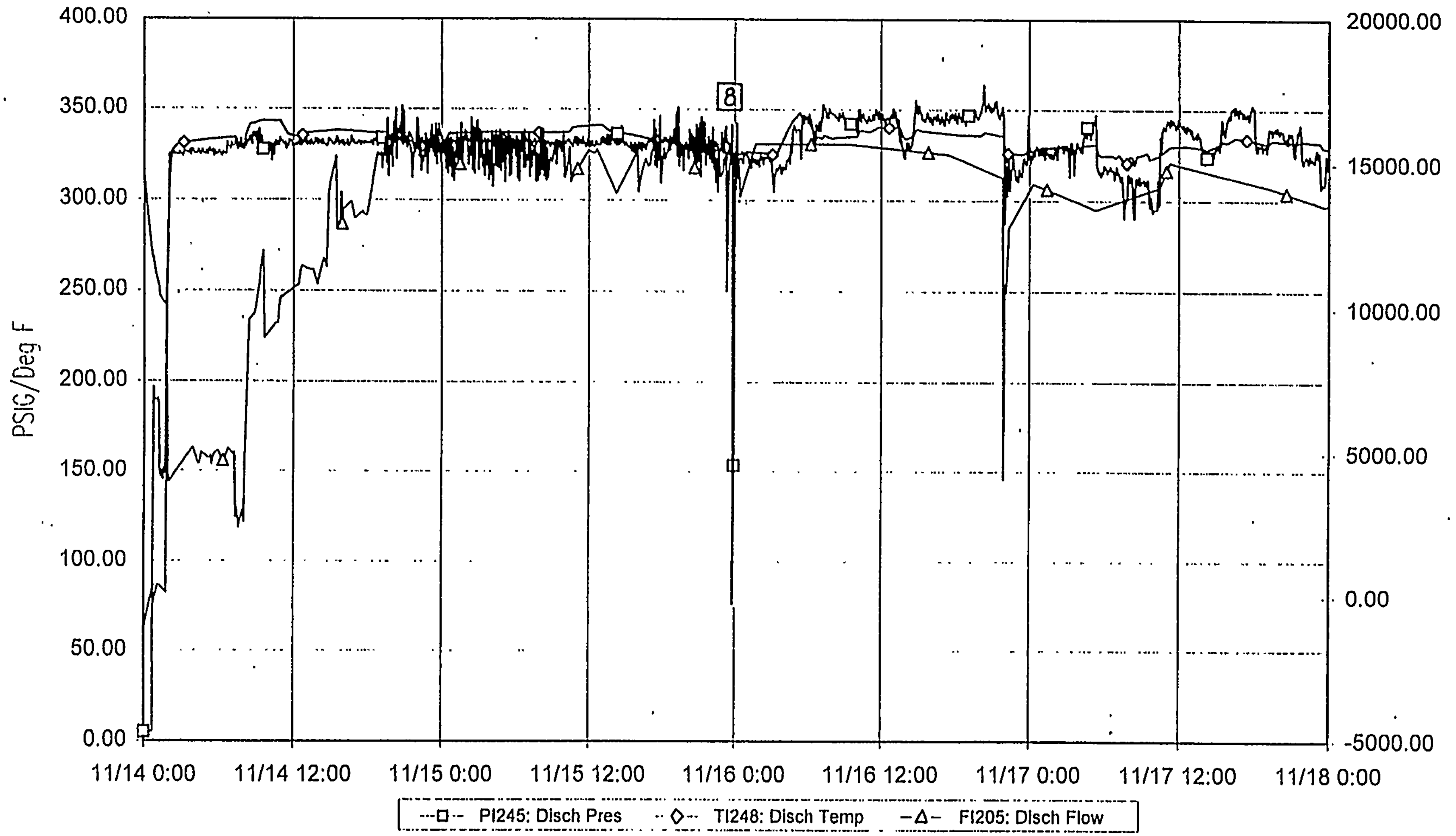
By 06:15 the coal feeder seemed to be working. At 06:20 a coal sample was taken from FD0210 surge bin to determine if coal was wet. The FD0220 motor speed was adjusted to provide 15 to 20 percent more speed above the design in order to achieve a higher coal feed rate using FD0220. At 07:00 FD0210 tripped and was restarted. At 07:05 FD0220 was started. At 09:13 the isolation valve on FD0210 surge bin was closed halfway and fluidization was checked. The fluidization rates were set at normal positions.

By 10:45 the FD0210 feeder was working better. At 11:30 coal was drummed out of FD0220 to add two drums of sand since the reactor standpipe level was low. At 12:00 there were hot spots in the reactor, and as a result, coal was batch fed to keep the maximum temperatures low (event 28, figure 5.1.10-36). The TI357 (top of standpipe) stopped increasing and the standpipe temperatures steadily decreased to a low level (about 300 to 400°F instead of 1,500 to 1,600°F). Even with addition of sand and circulation of solids from HX0203, the standpipe level did not show any increase (event 29, figure 5.1.10-41). Further increase in solids circulation from HX0203 resulted in higher carryover to PCD. It appeared that either a plug or a bridge was holding the solids keeping them from draining out of the disengager. Also, it is possible that the J-leg seal might have been lost due to a low solids level in the standpipe and that the reverse flow of gases through the standpipe prevented solids from flowing down the disengager and cyclone dipleg. At that point the process was shut down.

At 14:00 the coal feeder was shut down. At 14:20 the reactor pressure was reduced from 160 to 100 psig. All standpipe and reactor solids were removed by using FD0206. The standpipe solids were drained into FD0530 as the reactor system shutdown proceeded. The PCD was back-pulsed for an additional 2 hours. At 18:25 the main air compressor was shut down (event 30, figure 5.1.10-26).

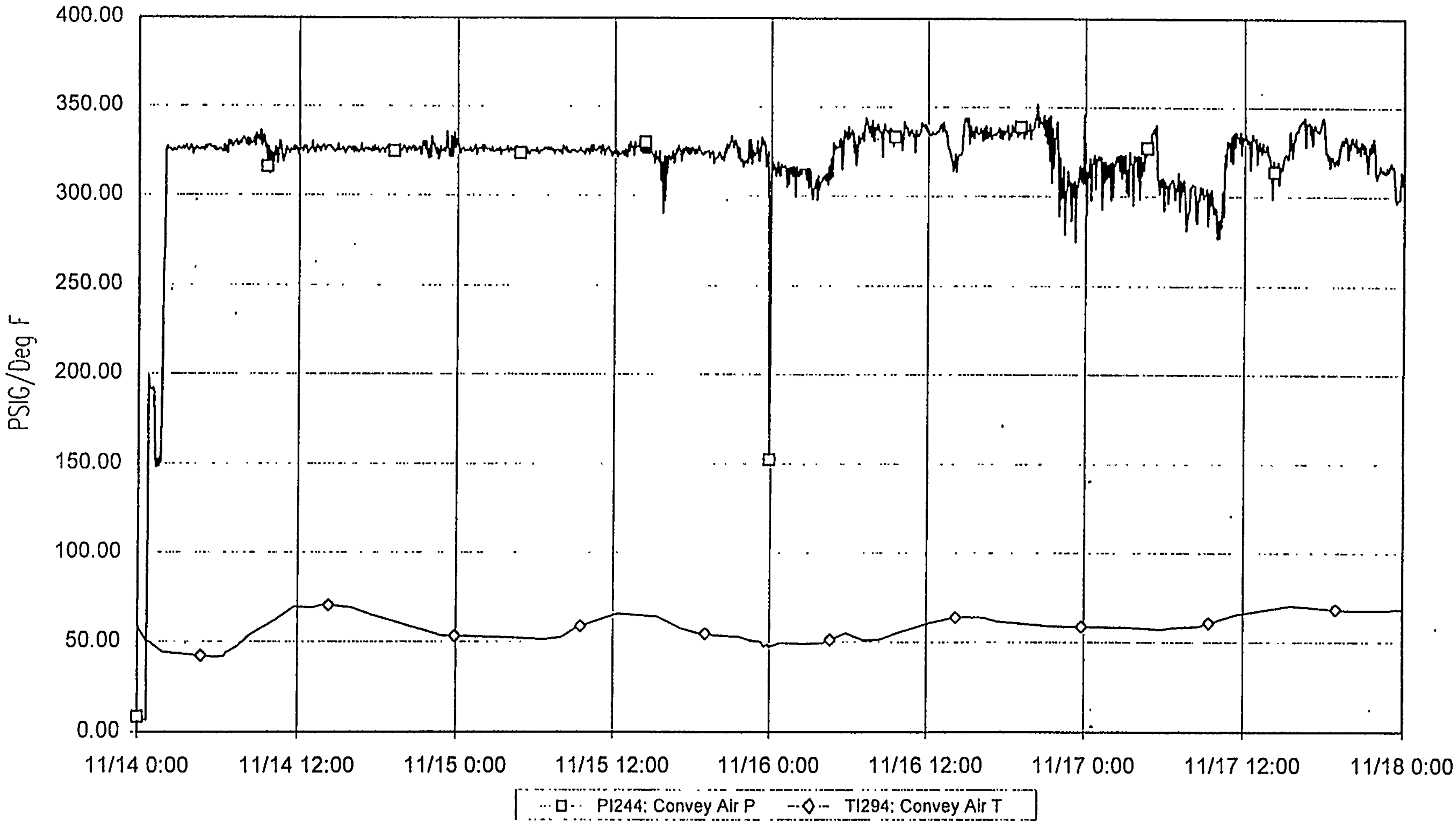
5.1.10.3 Test Run CCT2C Observations

This test run was a continuation of previous test runs that had ended prematurely. The solid circulation through the heat exchanger was poor during the first half of the test run due to bridging at the intersection of heat exchanger standpipe and J-leg. During the latter part of the test run uneven circulation through the heat exchanger J-leg caused wide fluctuations in the reactor temperature. The reactor temperature was gradually increased from 1,000 to 1,600°F using a mixture of coke breeze and subbituminous coal. Also, after a trip during this test run, reactor temperatures were increased from 1,200°F (with propane fire) to 1,600°F (with bituminous coal), avoiding the use of coke breeze and subbituminous coal. The transition was smooth. With coal feed, the reactor operations were maintained initially at 180 psig and then for the remainder of the test run at 160 psig. Sand was added intermittently in the beginning of the test run to maintain the reactor solids inventory. However, during the latter part of the test run the reactor solids inventory was self-sustaining from dolomite addition for sulfur capture and from the ash generated in the process. In this test run coal feed to the reactor was maintained for 132 hours.



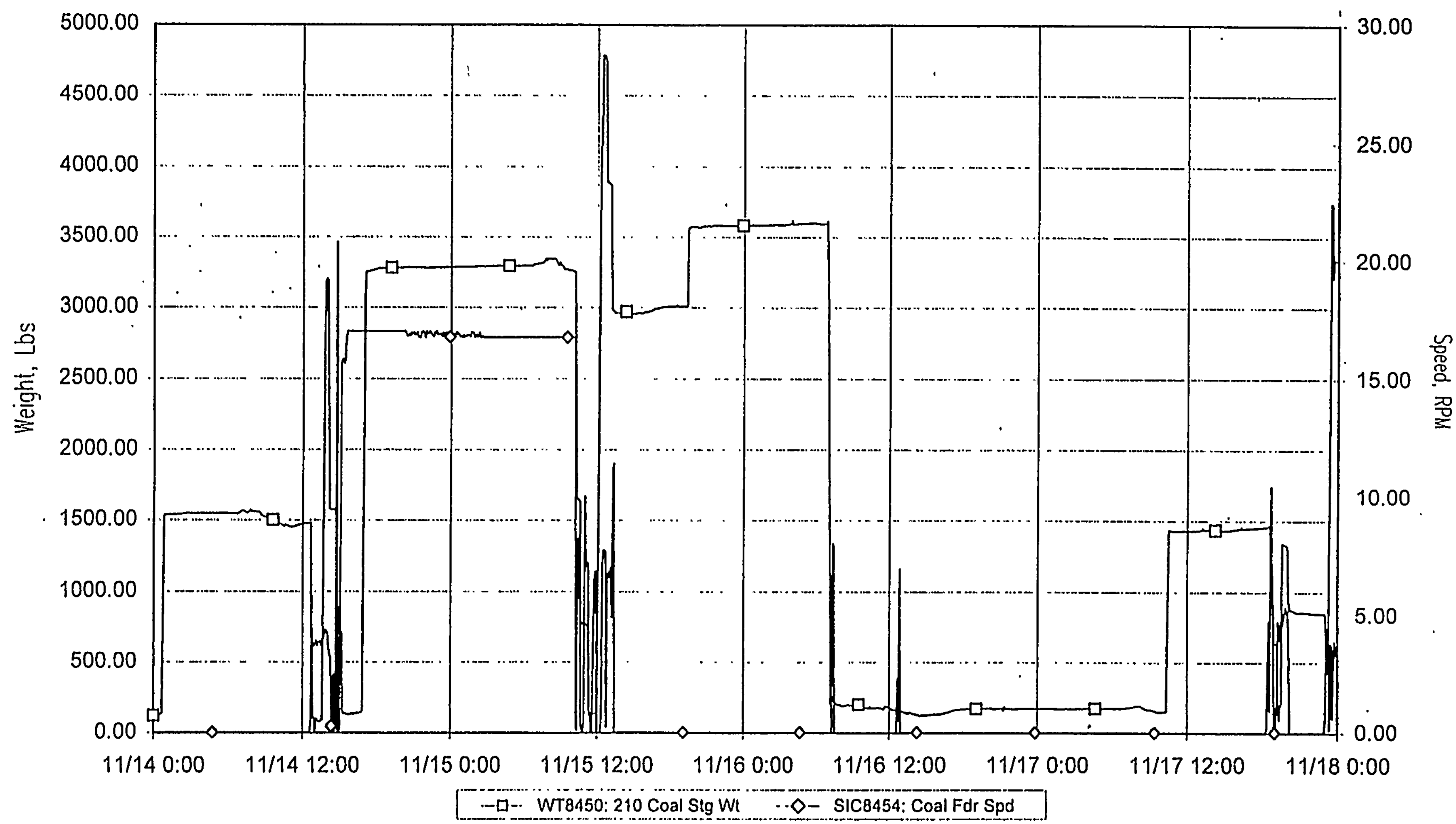
DOE Plot 1 of 45 - 5 minute data

5.1.10-1 C00201 System Profile for November 14 Through November 17, 1996



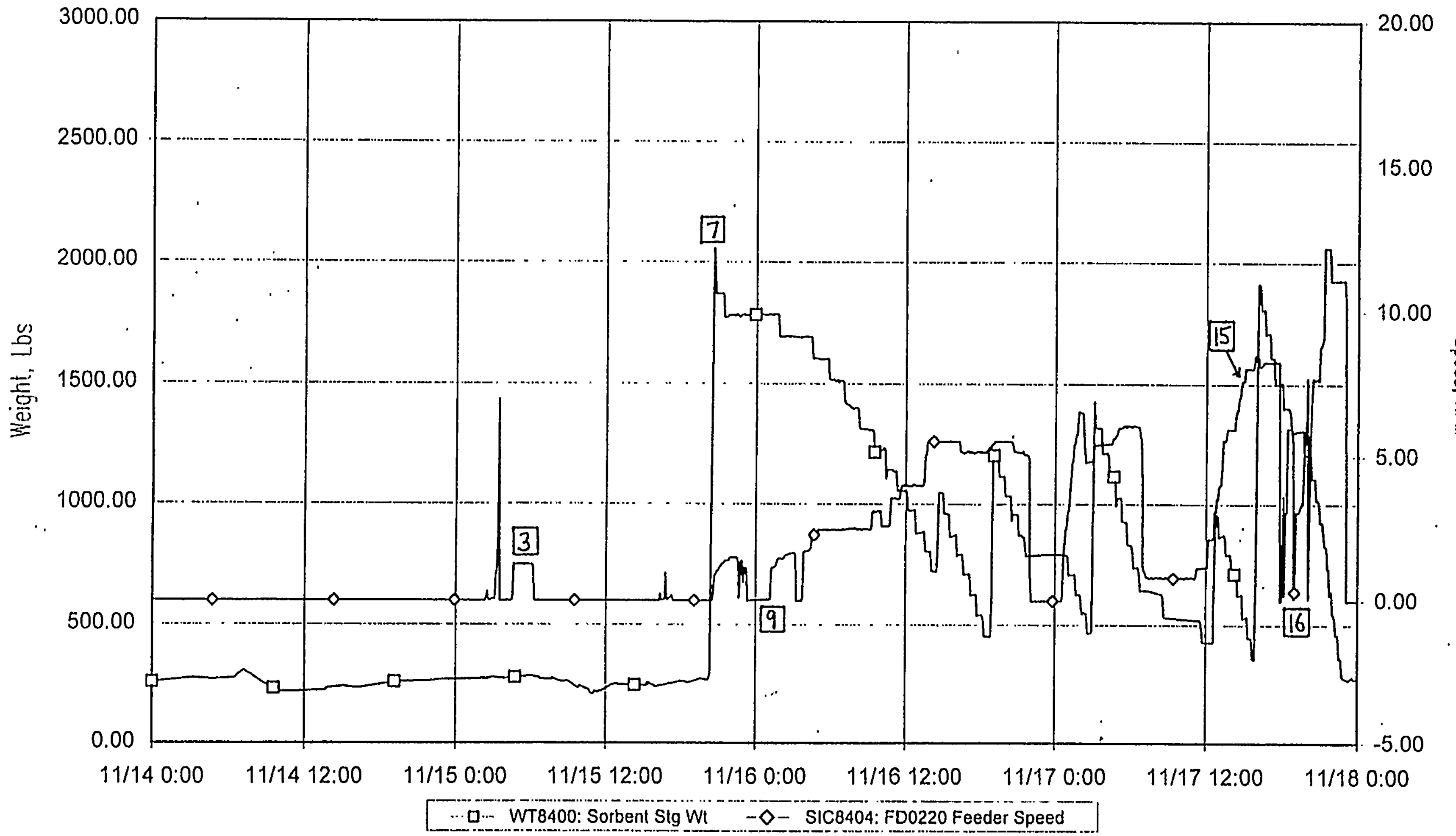
DOE Plot 5 of 45 - 5 minute data

5.1.10-2 Transport Air System for November 14 Through November 17, 1996



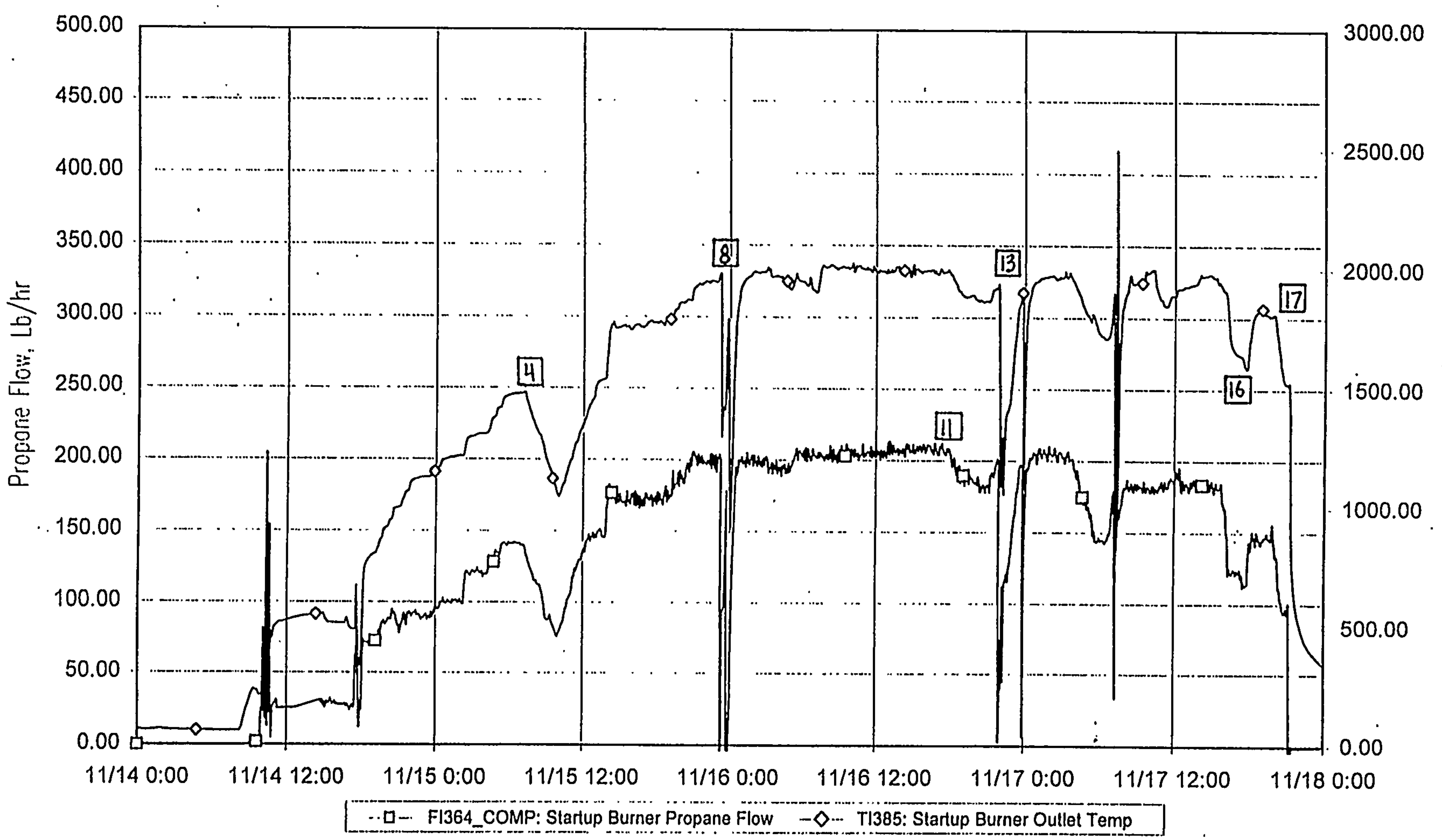
DOE Plot 7 of 45 - 5 minute data

5.1.10-3 Coal Feed for November 14 Through November 17, 1996



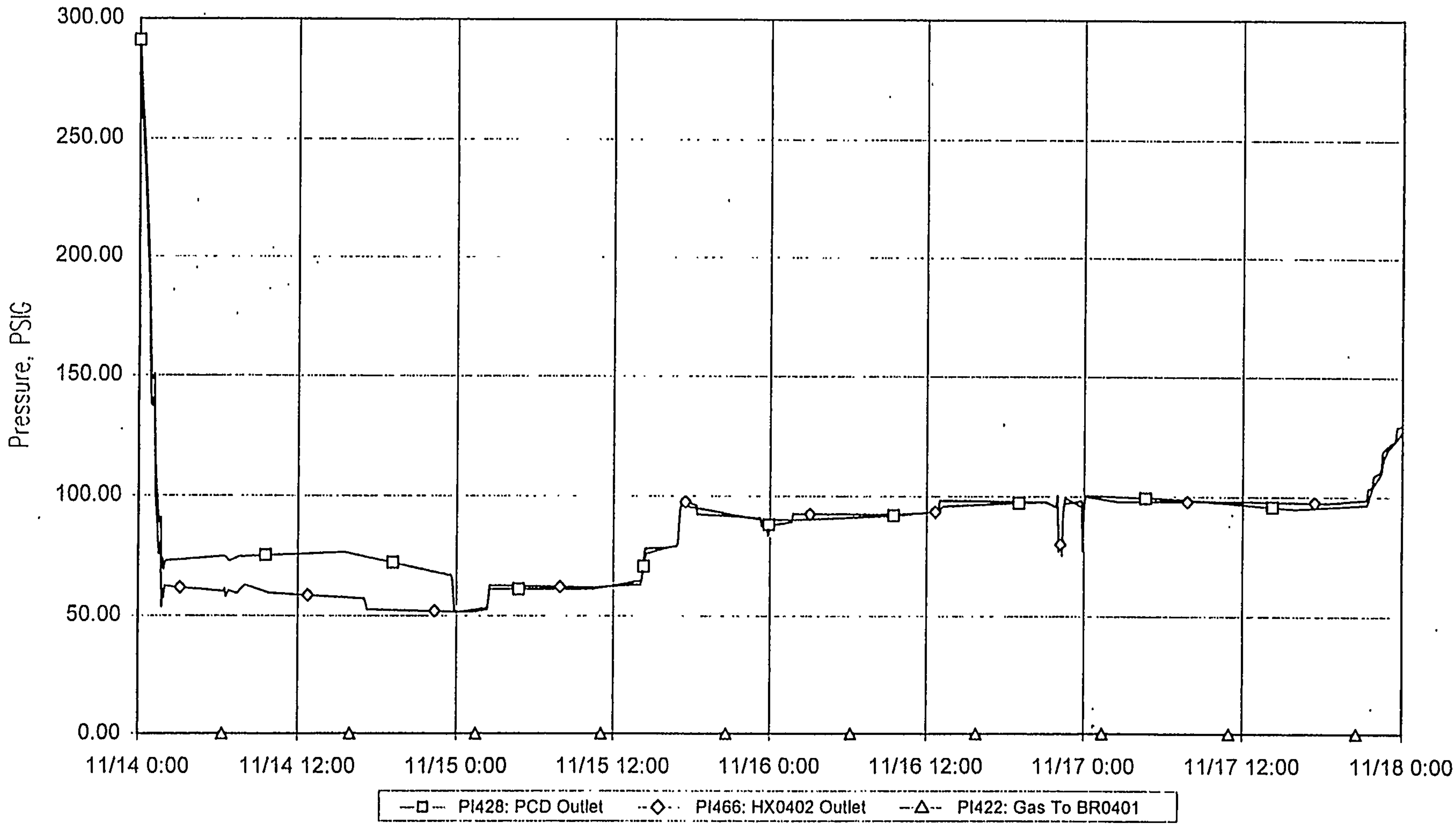
DOE Plot 9 of 45 - 5 minute data

5.1.10-4 Sorbent Feed for November 14 Through November 17, 1996



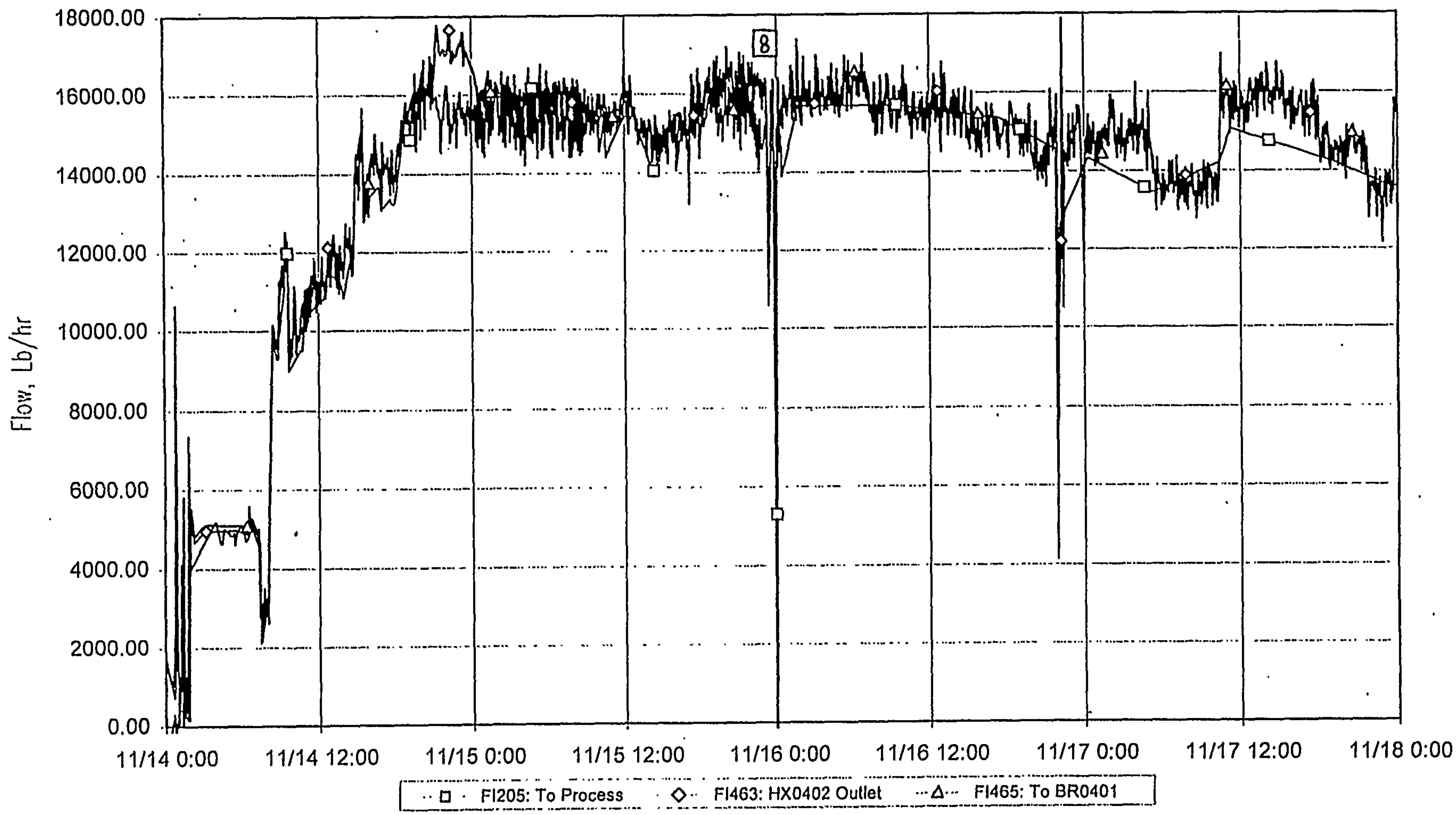
DOE Plot 11 of 45 - 5 minute data

5.1.10-5 Start-Up Burner Flow/Temperature for November 14 Through November 17, 1996



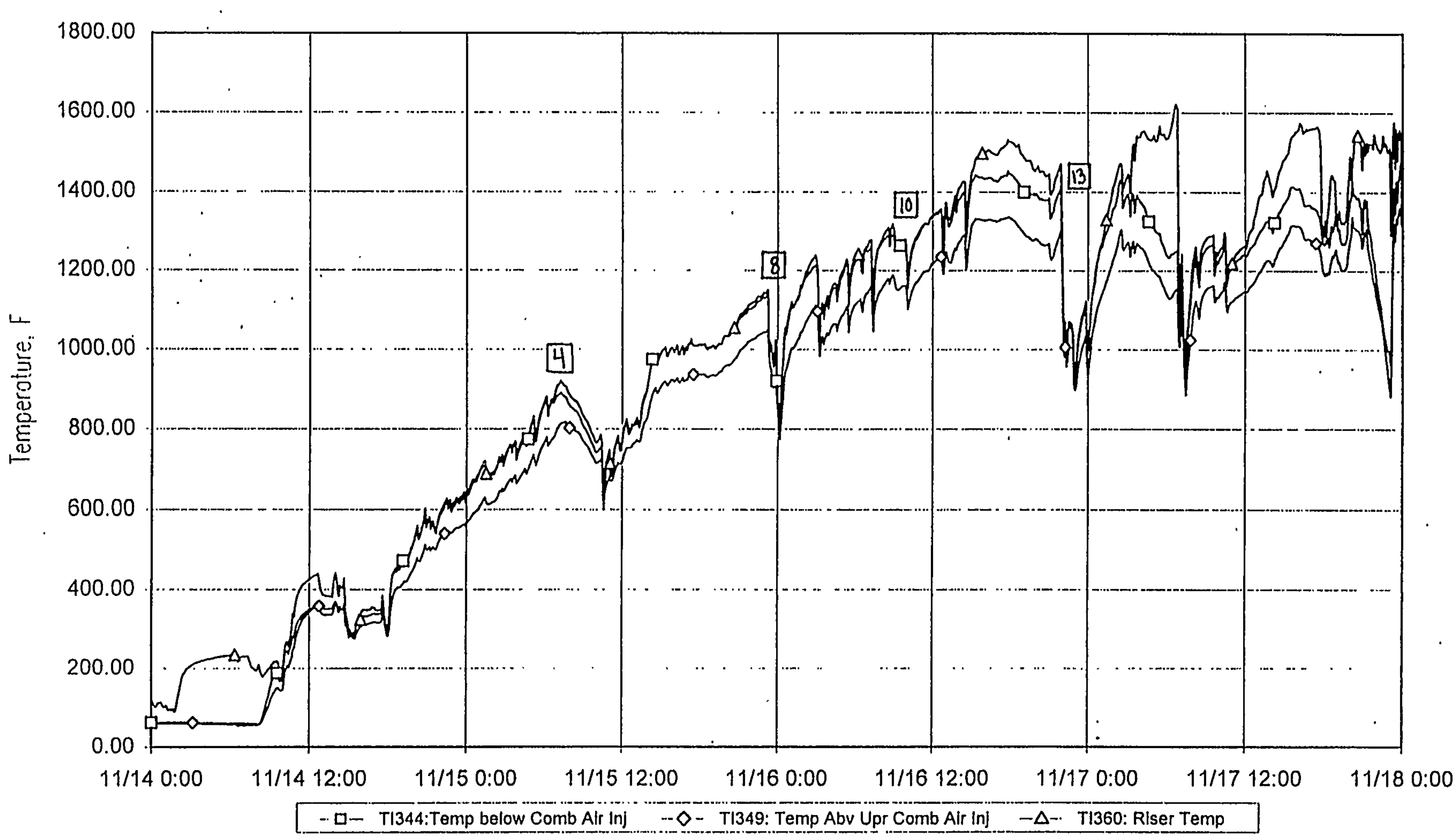
DOE Plot 12 of 45 - 5 minute data

5.1.10-6 System Pressures Downstream of PCD for November 14 Through November 17, 1996



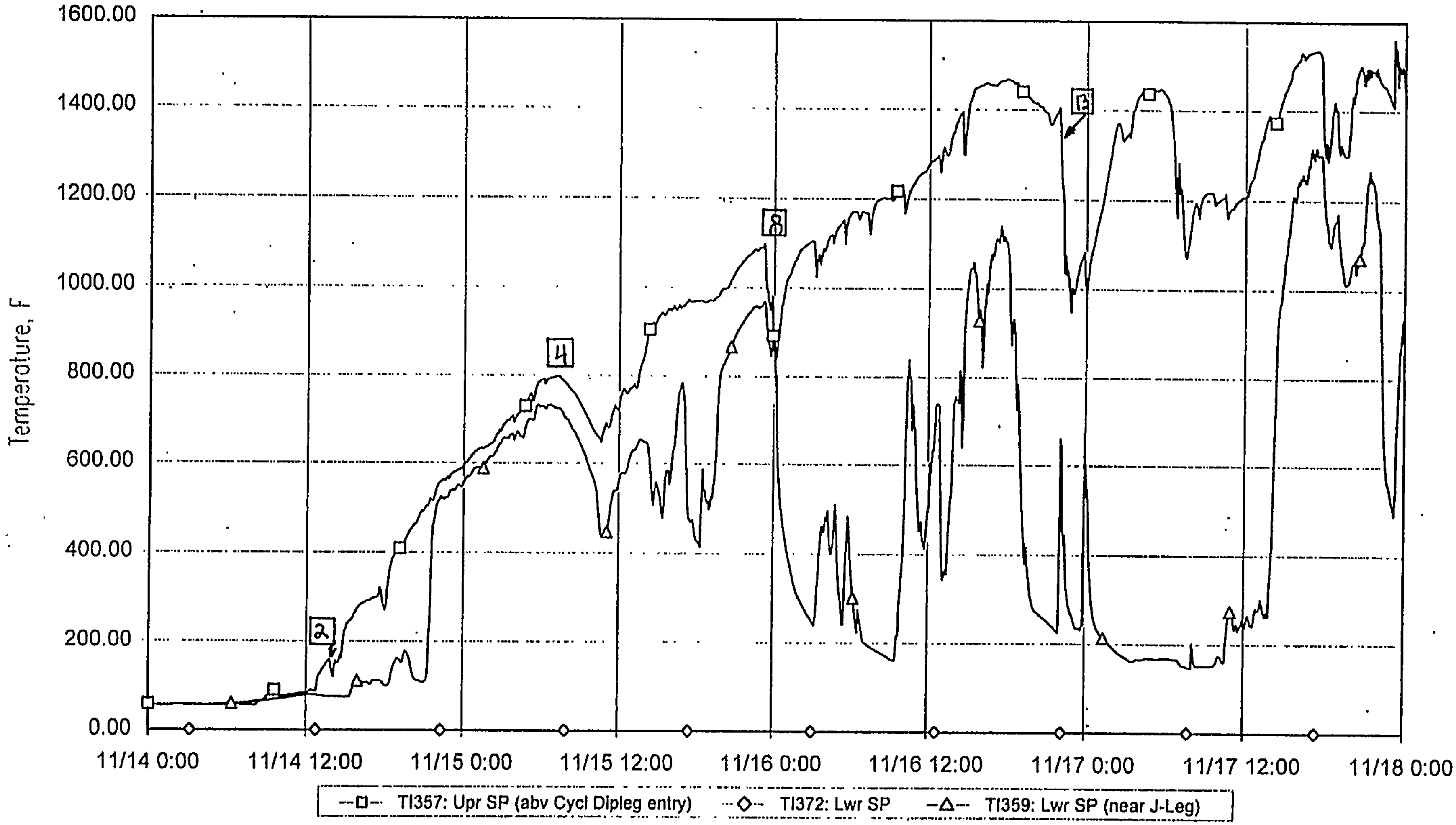
DOE Plot 13 of 45 - 5 minute data

5.1.10-7 Total Gas In/Out Flow Rates for November 14 Through November 17, 1996



DOE Plot 14 of 45 - 5 minute data

5.1.10-8 Reactor Mixing Zone and Riser Temperatures for November 14 Through November 17, 1996



DOE Plot 15 of 45 - 5 minute data

5.1.10-9 Standpipe Temperatures for November 14 Through November 17, 1996