CONOCO

Interoffice Communication

To Mr. John Levardsen, Saddle Brook

From R. W. Dillman, Ponca City

CWT 4

Date August 20, 1980

Subject VCM Delivery to CertainTeed

Since our August 14, 1980 meeting with CertainTeed, I have been reviewing several details of the turbine meter installation at CertainTeed as was requested by Mr. Gellner at that meeting. I have been in touch with Mr. Gil Green who is Product Specialist for Turbine Metering Systems with the Foxboro Company, Foxboro, Massachusetts. In reviewing the installation with him I was made aware of the following factors which may affect this installation.

The rate at which VCM is now delivered to CertainTeed from Conoco (approximately 135 to 175 gpm) falls dangerously close to the lower end of the turbine meters linear range which is 100 to 1000 gpm. Mr. Green informed me that if the flow were to any time drop below 100 gpm that the meters stated accuracy could not be assured. He also stated that if the flow rate fell below approximately 70 gpm that the turbine meter would fail to register any flow at all. A two inch turbine meter which has a linear range of 25 to 250 gpm was recommended by Mr. Green as a more suitable choice for the rates given.

Another factor which appears significant is the method of temperature compensating the turbine flow measurement to achieve a mass flow signal. The Foxboro equipment in the CertainTeed plant uses a linear relationship between temperature and specific gravity. However, the true relationship between temperature and specific gravity for VCM is decidedly non-linear. Since we feel that VCM is received by CertainTeed from Conoco over a wide temperature range, this appears to be an area where error can be introduced. A temperature compensation device which can better approximate this non-linear relationship is recommended. I am enclosing a product bulletin for one such device, the Daniel Industries Model 1863 Temperature Compensating Totalizer.

These two factors appear to me as significant enough to warrant further discussion with CertainTeed before entering into an agreement for a second meter installation. We are continuing to study the installation and plan to have data to verify these observations when we see you on August 27. If you have any questions, please let me know.

Robert W Dillman

Robert W. Dillman
Staff Engineer - Instrumentation
Central Engineering Department

lg
Att:
cc w/o att: REL RJA JAD GJF BAC

CWH 000009429

(conoco)

Interoffice Communication

CWT

To R. J. Andersen

From J. G. Dopper

Date June 12, 1980

Subject CertainTeed VCM Supply and Quantity Dispute

With reference to the report from J. F. Sheara dated April 11, 1980, I would like to add the following summary:

BACKGROUND

- 5-year VCM supply contract, starting January 1, 1978 for 27-32 MM lbs. annually.
- Conoco and CT agreed to build a pipeline and share the cost (with a maximum to CT of 25,000 $) 22
- Conoco had an option to supply an additional volume (40%-60% of CT total requirement of approximately 240 MM lbs. annually). If Conoco would not declare this option before October 1, 1978, Conoco would reimburse $250,000, the CT investments in the pipeline.
- Conoco did declare its option to supply the add volumes. CT insisted on a discount and our offer expired, since we were only forced to supply at contract conditions. Consequently, we did not reimburse the $250,000.
- Quantity determination as per contract called for gauging Conoco's shore tanks.

HISTORY

- Supplies only started in November 1978 due to delays in pipeline instruction.
- Prior to start-up we had a dispute on transfer pressure. Conoco agreed to install a low speed/pressure pump only for the purpose of transferring to CT costs fully paid by Conoco.
- Late 78 and early 79 CT verbally complained that they observed reduced conversion rates in their plant, although they never formally notified us, as is written in the contract.

  We requested some more data from CT which we only received in August 1979. Several meetings were held but no results were achieved.
- CT initially had no system to verify the received quantities of VCM. In June they attempted to standardize their filling procedure by using capacitance probes to measure starting inventory level (approx. 10% of tank level) and final inventory level (approx. 80% of tank level).

The capacitance probes were calibrated with infrared photography. CT claims the above system provided a 10% accuracy.

- Although CT is invoiced by the other supplier, PPG, on sphere tank measurements, CT seems to have access on data measured by PPG's idle, not calibrated flowmeter. These data seem to confirm CT's measurements. PPG has two devoted tanks from which they transfer to CT.

- Despite CT's conviction on accuracy of above system, they installed a flowmeter in the pipeline during October 1979. As far as we know, this flowmeter has not been calibrated yet (other than in the lab).

  Although in the beginning the measurements looked encouraging, the 1980 transfers were showing again a 7-8% negative variance for CT. Comparison with the PPG data showed a 1% positive variance for CT.

- Supply record, according to Conoco and CT data

	CONOCO	CT	DIFFERENCE
78	5,200,734	4,834,338	(366,396)
79	39,675,576	36,898,872	(2,776,704)
80	7,500,000 (thru May)	-	-

Based on average pricing in 78 and 79 the "discrepancies" amount to $483,000 over this period.

CONOCO TRANSFER SYSTEM

- Conoco is always transferring out of its storage tanks 411 A,B,C. From their tanks we have a pipeline to the docks (for barges and vessels) of approximately four miles. Branched from this we have a line to CT. In the line we have a high speed/pressure pump and a bypass with the special low speed/pressure pump for CT.

- Prior to transfer all the relevant valves are closed and the line is "packed".

- Then the relevant tank is gauged.

- CT is warned and the transfer is starting.

- Upon notice from CT we shut the valves and gauge again. This is repeated several times.

- We use correction tables for temperature differences.

COMMENTS

1) Although no valve is guaranteed "leak-proof" we cannot explain difference up to 10%. Furthermore, looking to the amount of valves in either direction, any leaks would be more at random, rather than one-sided in our favor.

2) Basically, we use the same system for loading vessels. Since 1977 we loaded 42 vessels of which:

   24 show an average of a 0.93% higher figure for shore tank measurements versus ship tank measurements

   18 show an average 0.89% higher ship's figures than shore

   Deviations are always at random and only on some incidents as high 3.9% discrepancies were found (2 cases).

   In overseas shipping we have the benefit of comparing shore L.C., ship after loading, ship before discharging and shore customer.

   The above shows us an average deviation of 0.9% which is acceptable in industry standards.

3) Of course, Conoco could consider to load cars at the same time we transfer. Being bad faith, we have not considered this to happen.

CERTAINTEED SYSTEM

- CertainTeed receives product in either one of two bullets, from which they load the reactors.

- Initially, conversion rates and capacitance probes were the measuring devices.

- Since October they installed a flowmeter.

- Each cylinder can take maximum approximately 500,000 lbs.

COMMENTS

1) We checked with two firms specialized in capacitance probes (Robertshaw and Drexelbrook).
   The consensus was basically:

   - capacitance probes (c.p.) are not accurate, particularly not for inventory control
   - c.p. are not to be used for non-conductive materials (VCM)
   - c.p. are heavily affected by temperature changes and changes in the dielectric constant (moisture)
   - general accuracy is said to be 2-3% under good circumstances

2) Use of infrared equipment for calibration levels of VCM.
In contacting infrared (I.R.) causing equipment manufacturers we found the following conclusions:

- I.R. not to be recommended for inventory control because of temperature gradient.
- Sunlight on the sphere could affect accuracy.
- Not used often for calibration service.

3) Conversion calculation, particularly over a short time span and small volume (1 MM lbs. maximum) are doubtful.

4) The tanks are in open connection with vapor return system. However, CT claims that the pressure difference would prevent leaks into that system.

The only other outlet is the daytank which is closed at the transfer.

PPG SYSTEM

Basically, the same system as Conoco with a few differences.

- Shorter line; can use high speed pump

- Dedicated system, closed by blind valves.

Based on the above, we concluded that:

1) Conoco's sytem by the fact of not seeing any major discrepancies in loading cars, barges or vessels is basically good.

2) We measure in bigger tanks via a static system which is deemed and accepted to be more accurate.

3. CT's, prior to the flowmeter devices, were not acceptable as level devices.

4. The short experience with the flowmeter which was not calibrated cannot prove that we have been wrong in the past. (I am convinced that if the meter would show now in 1980 numbers in CT's favor we would not be reimbursed either over the past 18 months delivery).

RECOMMENDATIONS

1) We do not see any justification to reimburse CT over deliveries prior to the flowmeter being calibrated.

2) For future deliveries we suggest to observe the transfers on both sides to get acquainted with the system.

3) Flowmeters when calibrated are accepted in the industry as being accurate (used by Dow, Shell). Therefore, I suggest to follow the results for some length of time to study any differences.

   In case, after familiarizing ourselves with their system, we still find differences, I suggest to either

   1. Work out an exchange with PPG
   2. Install our own meter (cost est. ± $60,000)

4) In any case, I feel we should never accept the customers reading as the invoice criteria. After all, we are in the VCM business. Even a housewife takes the measurements from the producer or sells of any goods as conclusive evidence.

J. G. Dopper

/tm

cc: JJL, REL, BEAL, JFS, MRS, CSC, JdeB, HDG

conoco

Interoffice Communication

To John Levardsen - Saddle Brook

From J. A. DeBernardi

Date August 8, 1980

Subject VCM Transfers - Certain-Teed

In July and again in August, our system for providing information to Certain-Teed related to transfers of VCM to them has tended toward the potential of embarrassment of both the Marketing and Product management areas as well as the plant. The delicate nature of our dealings with Certain-Teed indicates the need for all communications with them being well coordinated and understood within our organization prior to being passed on to them. To this end I suggest the following actions be considered.

1) Prior to any conversations with Certain-Teed on transfer volume and/or timing, the production and shipment plan by S&D be reviewed for possible conflicts.

2) The VCM Plant Process Superintendent be contacted to assure that plant problems or circumstances that might influence S&D's plan are included in the production and shipment plan being used for reference.

3) If conflicts arise, alternates be explored prior to contacting Certain-Teed and agreed upon as to their workability by S&D, the plant, and Marketing. The possibility of these conflicts also need to be made known to Certain-Teed up-front and not sneek into the system during the agreed upon transfer period.

4) The exact transfer quantity should be communicated to the plant by S&D or Marketing, not by the customer.

5) Responsibility needs to be assigned to S&D, Marketing, or the plant to make contact with Certain-Teed related to transfer plan, problems, and options, as well as quantity. Different stories to the customer from different people lead to confusion and embarrasement for all.

Certainly these suggestions will not eliminate all problems of communication with Certain-Teed. However, the setting of guidelines as suggested above and the adherence to their use by S&D, the plant, and Marketing will improve the present situation and eliminate a great deal of the confusion and potential for embarrassment that presently exists.

J. A. DeBernardi

CC: JWW-CWT-RDG-GGD-RJA-JGD

CONOCO

Interoffice Communication

To Distribution

From M. C. Jernigan and J. D. Morris

Date September 30, 1980

Subject VCM Custody Transfer

CWT
Final copy of report
For your files

INTRODUCTION

The purpose of this study is to determine the cause of transfer quantity discrepancies between our VCM plant and CertainTeed Corporation and offer recommendations for correcting the discrepancies.

SUMMARY AND CONCLUSIONS

During the month of September, the eleven VCM transfers between the VCM plant and CertainTeed were monitored by Conoco PED engineers stationed in both plants. The discrepancies for the eleven transfers varied individually from -5.2 percent to +9.2 percent with an overall average of +1.7 percent (+ indicates Conoco's measurement is greater). The total quantity transferred, as measured by Conoco for September, was 3,496,999 pounds. See Table I.

Several factors were found that probably explain prior discrepancies and, if corrected, can prevent future discrepancies. The most significant of these were procedural errors at CertainTeed which resulted in improper line packing. This appears to have occurred during four of the thirteen transfers in the month of July, causing differences as high as +25 percent. This error was discovered and corrected at the start of the first September transfer and did not effect any of the transfers. See Table II.

Other factors causing discrepancies relate to improper temperature correction by Conoco of the liquid VCM densities. One of the most significant is the difference in the actual temperature of VCM received by CertainTeed out of the pipeline versus the temperature used by Conoco to calculate the quantity pumped from the sphere.

Individual transfer calculation differences can also be shown to be the result of the inaccuracies of the mechanical devices used to measure sphere outage and temperature. These inaccuracies can cause differences as high as $\pm$6.0 percent.

Minor revisions to the transfer procedures at both the Conoco and CertainTeed plants and improved adherence to the procedures can reduce the major discrepancies.

Modifications to the system will be required in order for Conoco to accurately measure the amount of VCM transferred. The modifications should reduce the inaccuracies and errors to an average monthly discrepancy

TABLE I

SUMMARY SEPTEMBER TRANSFERS--CONOCO/CERTAINTEED

Transfer No.	Date	Time	Certainteed Meter Reading, Lbs	Conoco Reading, Lbs	Difference, Lbs(1)	%
1	9/11	15:32	311,500	320,768	+9,268	+3.0
2	9/12	4:11	317,450	346,733	+29,283	+9.2
3	9/12	16:27	314,740	326,957	+12,217	+3.9
4	9/13	5:54	309,600	312,264	+2,664	+0.8
5	9/13	11:50	313,150	309,168	-3,982	-1.3
6	9/14	3:35	311,230	321,033	+9,803	+3.1
7	9/14	7:50	305,960	290,879	-15,081	-5.2
8	9/15	1:16	315,780	322,831	+7,051	+2.2
9	9/15	5:40	313,850	311,358	-2,492	-0.8
10	9/15	23:15	320,670	327,261	+6,591	+2.0
11	9/16	3:50	304,050	307,748	+3,698	+1.2
Total			3,437,980	3,496,999	+59,059	+1.7

(1) + Denotes Conoco value is higher.

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TABLE II

SUMMARY VCM TRANSFERS--CONOCO/CERTAINTEED

YEAR TO DATE 1900

Month	CertainTeed Meter	Conoco Measured (1)	Difference (2)	%
January	1,095,920	1,095,234	-686	-0.1
February	1,594,150	1,733,814	+139,664	+8.8
March	1,690,130	1,758,137	+68,007	+4.0
April	1,511,200	1,575,964	+64,764	+4.3
May	-	-	-	-
June	-	-	-	-
July	4,269,810	4,581,599	+311,789	+7.3
August	3,133,044	3,203,812	+70,768	+2.2
September	3,437,980	3,496,999	+59,059	+1.7
October				
November				
December				
Year to Date	16,732,234	17,445,559	+713,325	+4.3

(1) Quantities as reported by the plant.
(2) + Denotes Conoco number is higher.

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SUMMARY AND CONCLUSIONS (CONTINUED)

of ±1.0 percent or less. These modifications include a new calculation method and new, improved instrumentation. Using the best available data from the September transfers, the revised calculational method yields an overall discrepancy of +0.9 percent. This is shown in Table III.

The turbine meter CertainTeed presently use is a four-inch meter with a range of 100 to 1,000 gpm. During transfers, the flow to CertainTeed averages around 250 gpm. During startup and completion of a transfer, the flow may fall to the lower accuracy range of the turbine meter or possibly even outside its range. During these periods, possible errors may occur in CertainTeed's reported amounts. No numbers are available, though, to quantify the accuracy of their meter.

A preliminary design for a turbine meter station for Conoco was prepared and is estimated to cost $200,000. Even though it is believed that a better than ±1.0 percent accuracy can be achieved by the meter station, Conoco would still have to monitor by tank gauge periodically to maintain our confidence in its accuracy.

The above error factors are summarized in Table IV.

DISCUSSION

1. Line Packing

The procedure used to transfer material to CertainTeed is the same procedure used for shiploadings. Essentially the procedure consists of (a) packing the transfer line with the transfer pump, (b) reading and recording the sphere level and temperature, (c) starting the transfer by opening the valve on the CertainTeed end, (d) stopping the transfer by closing the CertainTeed valve, (e) repacking the transfer line, and (f) reading and recording the sphere level and temperature.

At the start of the first September transfer, one procedural error was noted. The CertainTeed operator was opening the CertainTeed valve before line packing was complete. This was immediately corrected by CertainTeed.

As a result of this operational error, CertainTeed pressure chart recordings of the transfer line pressure for the months of July and August were reviewed. It was noted that the four excessive July transfer discrepancies occurred when the transfer line was not packed.

A Conoco operator packs the transfer line by making the proper valve adjustments for a transfer to CertainTeed and starting the pump with the CertainTeed valve closed. When the pressure in the transfer line reaches the pump deadhead pressure and stabilizes (approximately 150 psig), the line is assumed to be full of liquid VCM.

TABLE III

SEPTEMBER 1980 TRANSFERS

OLD-NEW METHOD VERSUS CERTAINTEED

Transfer No.	Date	AVERAGE TEMP, °F Sphere	AVERAGE TEMP, °F Transfer Line	CertainTeed Reading, Lbs	VCM Plant Calculation, Lbs	Difference from CertainTeed, Lbs	% Difference	New Calculation Method, Lbs	Difference from CertainTeed, Lbs	% Difference
1	9/11	82	97	311,500	320,768	+9,268	+3.0	309,986	-1,514	-0.5
2	9/12	83	80	317,450	346,733	+29,283	+9.3	325,173	+7,723	+2.4
3	9/12	84	94	314,740	326,957	+12,217	+3.9	323,967	+9,227	+2.9
4	9/13	83	80	309,600	312,264	+2,664	+0.8	312,547	+2,947	+1.0
5	9/13	83	94	313,150	309,168	-3,982	-1.3	304,502	-8,648	-2.8
6	9/14	82	80	311,230	321,033	+9,803	+3.1	322,594	+11,364	+3.7
7	9/14	81	84	305,960	290,879	-15,081	-5.2	292,746	-13,214	-4.3
8	9/15	82	82	315,780	322,831	+7,051	+2.2	324,803	+9,023	+2.9
9	9/15	80	80	313,850	311,358	-2,492	-0.8	314,586	+736	+0.2
10	9/15	81	83	320,670	327,261	+6,591	+2.0	328,834	+8,164	+2.5
11	9/16	80	82	304,058	307,748	+3,698	+1.2	309,369	+5,311	+1.7
Total				3,437,980	3,496,999	+59,059	+1.7	3,469,107	+31,127	+0.9

(1) + Denotes Conoco value is higher.

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TABLE IV

VCM CUSTODY TRANSFER

Error Factors	RANGE OF INACCURACY(1) %	RANGE OF INACCURACY(1) Lbs	Recommendations to Correct	ACCURACY AFTER CORRECTION %	ACCURACY AFTER CORRECTION Lbs
1. Line Packing	+2.6	+84,000	Install pressure recorder. Adhere to operation procedure.	-	-
2. Density Correction	+1.7	+5,100	Incorporate new transfer calculation method and line temperature recorder.	Unknown	Unknown
3. Varec Gauges	±1.0	±3,000	Change strapping table.	±0.5	±1,500
4. Sphere Temperature					
a. Old Method of Calculation	±6.5	±19,500	Install thermocouples with digital readout.	1.6	±4,800
b. New Method of Calculation	±<0.1	-	N/A	-	-
5. Sphere Temperature Gradients	±3.5	±10,500	N/A	-	-
6. Density Correlation	-	-	Use most accurate density correlation.	Unknown	Unknown
7. CertainTeed	Unknown	Unknown	Reduce operation error. Maintain flow above 100 gpm.	Unknown	Unknown
8. New Metering System (Optional)	-	-	Install turbine meter system.	0.5	1,500

(1) Based on a 300,000-pound transfer.

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DISCUSSION (CONTINUED)

1. Line Packing (Continued)

If the transfer line is not packed before a transfer, the initial sphere level gauging will be incorrect. Additional material must be used to liquid fill the line; this VCM is, of course, not received by CertainTeed. Figures 1 and 2 are copies of two July transfer line pressure recordings.

Figure 1 is the pressure chart for July transfer No. 8, showing the line was packed correctly both before and after the transfer. The discrepancy for the transfer was less than 0.1 percent.

Figure 2 shows very clearly that the transfer line was not packed before the No. 4 transfer was started. The result was a discrepancy of 83,946 pounds, or 24 percent. July transfers Nos. 6, 10, and 12 also have line pressure records which show the transfer line was not packed. These transfers had discrepancies of 24 percent, 19.7 percent, and 26 percent, respectively.

The installation of a pressure recorder in the Conoco control room to record the transfer line pressure would aid in assuring proper line packing and in determining process upsets during transfer. The installation of the recorder and improved adherence to the operating procedure by both Conoco and CertainTeed can eliminate the major discrepancies caused by improper line packing.

2. Density Correction

The method used by Conoco for calculation of material transferred is an indirect method and is based on a volumetric measurement. The level in Conoco's sphere is recorded before and after each transfer. These values are then converted to gallons of liquid and vapor by the sphere strapping tables. The gallons of vapor and liquid are multiplied by their densities and added together to obtain the total number of pounds in the sphere. The densities are determined by the sphere temperature and the VCM density charts. To obtain the pounds transferred, the mass in the sphere at the end of the transfer is subtracted from the mass at the start.

The six-inch CertainTeed line and the section of ten-inch dock line used to transfer VCM to CertainTeed together have a volume of 46,672 gallons. An average VCM transfer of 300,000 pounds at 80°F has a volume of 40,010 gallons. The material that CertainTeed would receive from this transfer would be VCM that was displaced from the transfer line and not the material taken from the sphere during that transfer.

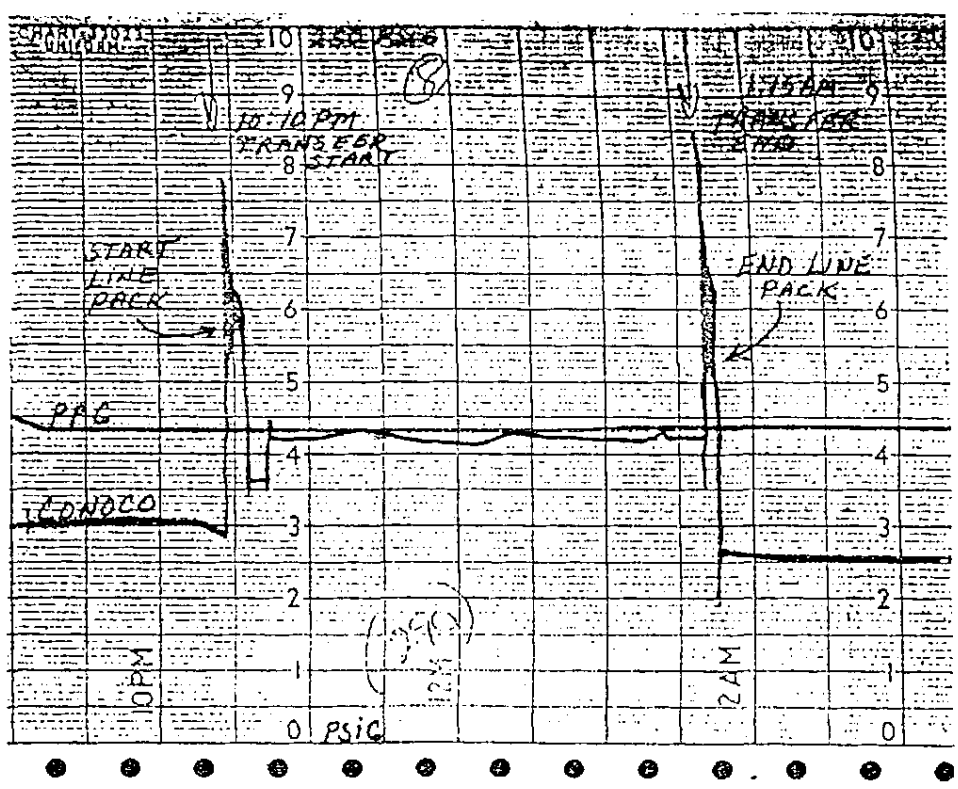
During the September transfers, the temperature of material received by CertainTeed often exceeded the sphere temperature by 20°F. The

FIGURE 1

TRANSFER LINE PRESSURE RECORDING

JULY TRANSFER NO. 8

JULY 18, 1980



CertainTeed Meter Reading, Lbs	Conoco Measured, Lbs	Difference, Lbs	%
322,340	322,050	-290	-0.09

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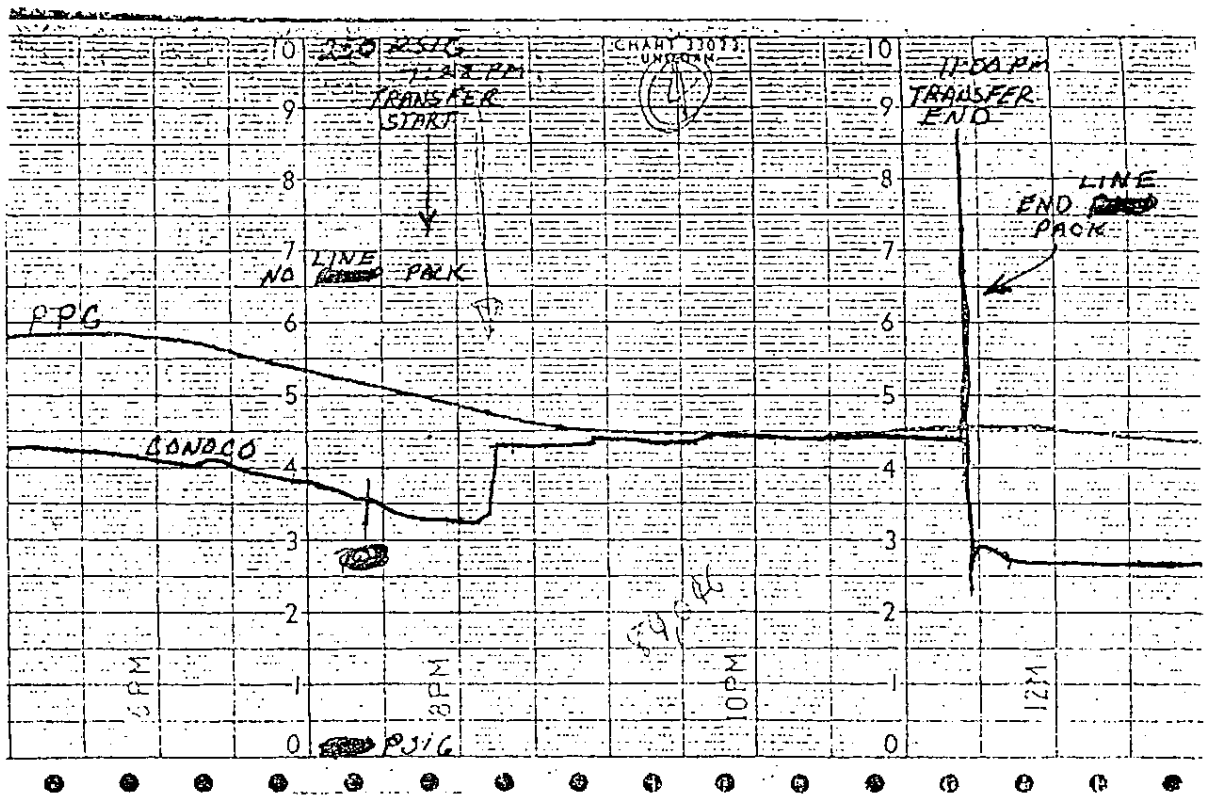
FIGURE 2

TRANSFER LINE PRESSURE RECORDING

JULY TRANSFER NO. 4

JULY 16, 1980



CertainTeed Meter Reading, Lbs	Conoco Measured, Lbs	Difference, Lbs	%
347,420	431,366	+83,946	24.2

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DISCUSSION (CONTINUED)

2. Density Correction (Continued)

first transfer in September had an average sphere temperature of 82°F, while the CertainTeed temperature averaged 97°F. The density of VCM at 82°F is 1.7 percent greater than the VCM density at 97°F. The volume taken from the sphere displaced the same volume in the liquid full transfer line to CertainTeed, but the mass of the volume taken from the sphere was 1.7 percent larger than the mass of the volume CertainTeed received. The discrepancy in a 300,000-pound transfer, as a result of this 1.7 percent error, would have been 5,100 pounds.

It is suggested the following method for calculating transfer quantities replace the existing method used by the VCM plant.

The sphere outage in gallons would be recorded for each transfer. The density for VCM at the average temperature of the material CertainTeed received would be multiplied by the sphere outage in gallons. The resulting mass would be the correct number of pounds CertainTeed received. This has been done on a trial basis for the September transfers, and the results are shown in Table III. The maximum individual trasnfer discrepancy has been reduced to 4.3 percent from 9.2 percent, while the overall difference is down to 0.9 percent from 1.7 percent.

This method would correct the error caused by the temperature difference in the material CertainTeed received versus the temperature of the material pumped into the line from the sphere. A device for averaging and recording the temperature of the VCM in the line at CertainTeed would be required for this calculation method to be routine. The recording device would be installed in the Conoco control room, or more economically at CertainTeed. A complete and detailed procedure for this calculation method will be prepared by PED.

3. Varec Gauges

CED Standards recommend for remote tank gauging the use of instruments with accuracies of ±1°F for temperature and ±1/16-inch for level. The standards also recommend the instruments used for these measurements be electronic with digital readout.

The Varec gauges used for reading the sphere levels have accuracies of ±1/16-inch; but in conjunction with the strapping tables, the outages determined by level are accurate only to ±1/8-inch. A level readout from the middle third of the sphere could be in error ±225 gallons. This can effect the accuracy of an average 300,000-pound transfer by up to ±1.0 percent or up to ±3,000 pounds.

DISCUSSION (CONTINUED)

3. Varec ?Gauges (Continued)

The use of the Varec gauges is believed to be adequate for these measurements, although it is recommended the sphere strapping tables be recalculated for 1/16-inch increments. This would increase the accuracy of the outage determihation to ±1/16-inch and reduce the effect on transfers to a maximum of ±1,500 pounds.

4. Sphere Temperature

The bimetallic temperature gauges on the spheres have, at best, a temperature accuracy of ±2°F. The temperatures recorded from the gauges are used to determine density values in the sphere capacity calculation. The error caused by the ±2°F inaccuracy has the same effect as using the wrong density values. The inaccuracy can effect a 300,000-pound transfer using the existing calculation method by up to ±6.5 percent or ±19,500 pounds. Using the new calculation method, the effect would be less than ±0.1 percent.

5. Sphere Temperature Gradients

During transfers, it has been observed that the VCM in the sphere is often in isothermal layers. This was observed during the September transfers as the temperature of the sphere changed from the initial gauging to the final gauging. This change was as high as 1°F to 3°F. Since the uniform temperature of the sphere is needed to determine a true mass in the sphere, the use of the initial and final tempratures for transfer calculations will cause inaccuracies. A 1°F to 3°F change will cause inaccuracies from ±2.0 to ±3.5 percent or ±6,000 to ±10,500 pounds in a nominal 300,000-pound transfer.

In order to achieve a uniform temperature in the sphere, the sphere would have to be recirculated for a long period of time. A reasonable time frame of twelve hours or less for recirculation would be ineffective in achieving a uniform temperature. No recommendations for improving this problem are made at this time, since the revised procedure will not be significantly affected by this problem.

6. Density Correlation

The liquid density tables used by the VCM plant are based on a linear equation while the VCM density data in the PED VCM Data Book is nonlinear. The latter data shows higher density values for VCM in the temperature range of 60°F to 100°F than the linear equation does, 0.23 percent higher at 70°F, and 0.6 percent higher at 85°F. The deviations would affect the calculations of the transfers by the same margins (obviously in Conoco's favor). The effect on the CertainTeed calculated quantities would be the same, since they have been using the density correlation supplied by Conoco.

DISCUSSION (CONTINUED)

6. Density Correlation (Continued)

Verification of the accuracy of either data source has not yet been made. PED will continue the investigation to determine which data is more accurate.

7. CertainTeed Meter

The existing method used by CertainTeed for measuring VCM transfers is a four-inch turbine meter system with temperature compensation. The meter has an operating range of 100 to 1,000 gpm. Conoco presently transfer at a pumping rate of 200 to 300 gpm. During initial startup or transfer completion or if a transfer upset occurs, the pumping rate to CertainTeed may fall below 100 gpm. R. W. Dillman's letter of August 20, 1980, to John Levardsen suggests that significant inaccuracies in CertainTeed's meter system will occur if the flow rate falls below the lower operating range of the meter. We do not have any data that quantifies this error. Dillman also addresses the effect of the method of temperature compensation on the turbine flow measurement to achieve a mass flow signal. The use of the linear versus nonlinear VCM density data by CertainTeed would have the same effect on transfer quantities recorded by CertainTeed, as discussed in paragraph 6 above. Recommendations will be made after PED's density study is complete.

8. PPG Shipments

CertainTeed receive the bulk of their VCM requirements, 85 percent, from an adjacent PPG plant, while Conoco supply approximately 15 percent of CertainTeed's VCM needs. Although PPG use the same methods for transferring to CertainTeed, their system is not as complex as Conoco's. PPG's piping is shorter, more direct, and can be completely isolated for transfers to CertainTeed. It is also understood that the majority of the piping is underground, thus preventing some of the thermal problem Conoco encounter.

9. New Metering Station

A preliminary design for a custody transfer metering system has been prepared by CED's Instrumentation Section. The metering system will consist of two turbine meters, one a billing meter and the other a check meter. The turbine meter signals will be temperature compensated and totalized to provide a mass flow signal. The mass flow signals will be telecommunicated to the VCM plant control room where a card printer will issue a ticket documenting the transfer.

DISCUSSION (CONTINUED)

9. New Metering Station (Continued)

A preliminary estimate by CED has determined that a capital investment of $200,000 will be required for the installation of the metering system. It would be installed on CertainTeed's property near the inlet to their storage tanks. The system will require a periodic maintenance and calibration schedule.

As stated in the preliminary design, the system was designed from Conoco's experience with custody transfer monitoring systems on the Conoco/Monsanto Joint Venture and also based on industry standards set by the American Petroleum Institute and the Instrument Society of America.

From literature, it is reported that a turbine meter system can achieve accuracies of ±0.5 percent. Although it is not known what actual field accuracies a meter system in this service will have, it is believed that an accuracy of better than ±1.0 percent could be achieved.

The metering system will have a built-in self-check capability which will register any discrepancies between the two meters. Even with this capability, it is recommended that periodic checks be made by tank outage to insure meter accuracy.

IN PERSPECTIVE

The comparison of discrepancies in loading ships to that of transfers to CertainTeed is a very unequal comparison. While CertainTeed transfers range in quantities of 300,000 to 350,000 pounds, shiploadings are in the range from 2,500,000 pounds to 23,000,000 pounds. A ±1 percent discrepancy in CertainTeed shipments would range from ±3,000 to ±3,500 pounds. This same error would be unnoticable in a shiploading.

Many of the factors that would affect the CertainTeed transfer accuracy would have an insignificant effect on the accuracy of shiploadings. The major factor which seems to affect the accuracy of both shipment calculations is the inaccuracy of the temperature used in the calculation. Both the inaccuracy of the sphere's bimetallic temperature devices and the problem of VCM being in isothermal layers in the storage tanks were pointed out in L. D. Jensen's 1976 report to R. W. McPherson on VCM shiploading discrepancies.

SUMMARY OF RECOMMENDED ACTION STEPS

The following is a list of PED action steps required for the incorporation of the new transfer quantity calculation method and other improvements:

1. Prepare a complete and detailed procedure for the new calculation method.

2. Prepare a design for instrumentation to record the temperature of the VCM in the transfer line directly before the CertainTeed metering system and to calculate a time-weighted average temperature during the transfer.

3. Prepare a design for instrumentation to record pressure in the transfer line.

4. Recalculate sphere strapping tables for 1/16-inch increments.

5. Prepare operational procedure and assist in training operations.

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CC:
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JCL:GJF:RWC:JADe:JWW