OSR 45-24 (Rev 11-15-2004)

Calculation Cover Sheet

Project CMP Pits Electrical Resistance Heating/Soil Vapor Extraction	Calculation No. M-CLC-G-00344	Project No. 1201
Title CMP Pits Soil Vapor Extraction (SVE) Wells Flow Analysis	Functional Classification GS	Sheet 1 of 43
	Discipline Mechanical	
Calc Level ☒ Type 1 ☐ Type 2	Type 1 Calc Status ☐ Preliminary ☒ Confirmed	
Computer Program No. Crane Companion (EA1C-M-202V) ☐ N/A	Version/Release No. 3.65	

Purpose and Objective

The purpose of this calculation is to;

1. Determine the heat loss associated with the piping and the rubber hoses.
2. Determine the head loss across the CMP Pits SVE wellheads and connecting piping to the Heat Exchanger Skid.

Summary of Conclusion

1. The heat loss from the piping/hose arrangement will be between 46.08 and 74.48 BTU/lbm.

   Note: The heat loss from the piping/hose arrangement will be used to determine the potential amount of condensate that will accumulate in the piping/hoses for collection tank sizing.

2. The head loss across the system (well head to inlet of heat exchanger) will be approximately 1.55 "Hg. The pressure at the heat exchanger skid inlet will need to be 22.45 "Hg absolute to provide sufficient vacuum for system.

Revisions

Rev No.	Revision Description
0	Initial issue

Sign Off

Rev No.	Originator (Print) Sign/Date	Verification/ Checking Method	Verifier/Checker (Print) Sign/Date	Manager (Print) Sign//Date
0	Chris Schilling Chris Schilling 4/26/05	DESIGN REVIEW	Michael Layman Michael P Layman 4/26/05	for Damon Hurley Damon Hurley 4/27/05

Design Authority — (Print) N/A	Signature N/A	Date N/A
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Security Classification of the Calculation
UNCLASSIFIED

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1.0 OPEN ITEMS

1.1 NONE

2.0 REFERENCES

2.1 Q-MT-L-00001, Rev. 1 Redline, Modification Traveler For Chemicals, Metals, Pesticides (CMP) Electrical Resistance Heating/Soil Vapor Extraction (U).

2.2 M-CLC-G-00341, Rev. 0, Fluid Analysis for 500 kW Heating Operation With a 100 Ton Cooling Tower.

2.3 Fundamentals of Classical Thermodynamics, John Wiley & Sons, Van Wylen et al, 4th Edition, 1994.

2.4 Flow of Fluids Through Valves, Fittings, and Pipe, Technical Paper No. 410, Crane Co., 1988.

2.5 Elements of Heat Transfer, McGraw-Hill, Bayazitoglu and Özişik, 1988.

2.6 2001 ASHRAE Fundamentals Handbook, Chapter 27, Climatic Design Information.

3.0 ASSUMPTIONS

3.1 There will be an upper and lower heating zone consisting of four discreet heating campaigns:

3.1.1 Lower zone – will consist of seven electrodes. Each electrode has an upper and lower electrode plate. The lower electrode plates will be energized during the first heating campaign. The second heating campaign will involve removing the electrical wiring from the connectors of the lower electrode plates and attaching them to the upper electrode plate connectors (see Attachments 8.1 & 8.3).

3.1.2 Upper zone – will consist of nine electrodes. Six electrodes will have an upper and lower electrode plates. The center electrode will only have a lower electrode plate. The remaining two electrodes will only have upper electrode plates. The remaining two heating campaigns will be similar to the lower zone with the exception of using eight electrodes when heating the soil with the upper electrode plates (see Attachments 8.1 & 8.3).

3.2 The new wells (defined in Ref. 2.1) not actively being heated during the four heating campaigns will be online and throttled, as necessary, in order to prevent exceeding the operational limits of the Soil Vapor Extraction (SVE) components (e.g., blower, heat exchanger, etc.) and minimize the generation of condensate in the SVE hose/piping due to mixing of steam vapor with non-heated wells.

3.3 The results presented in Ref. 2.2 will be used as input for the computations.

3.4 Heat loss computations will use an ambient temperature of 21°F and 96°F and a mean wind speed of 5 miles per hour (Ref. 2.6, Table 1A & 1B, for Augusta, GA).

3.5 Rubber hose, CPVC pipe and carbon steel pipe have the same inside and outside dimensions.

3.6 The air introduced by the non-heated wells will be considered at 60°F (temperature of the ground). The steam vapor will be considered saturated at 200°F, 24"Hg absolute.

4.0 INPUT

4.1 Air

4.1.1 Molecular Mass (M) = 28.97, Ref. 2.3 (Table A.10E)

4.1.2 Specific Heat Ratio (k) = 1.400, 80°F, Ref. 2.3 (Table A.10E)

4.1.3 Volumetric flow rate of air (Q_a) from heated SVE wells = 213 ft^3/min @ 200°F & 24"Hg abs., Ref. 2.2

4.1.4 Density of air (ρ_{a200}) = 0.05995 lbm/ft^3, @ 29.92"Hg abs. and 200°F, Ref. 2.5 (Table B-1)

4.1.5 Density of air ($\rho_{a200,24}$) = ρ_{a200}*(24"Hg/29.92"Hg) = 0.04809 lbm/ft^3, @ 24"Hg abs. and 200°F

4.1.6 Mass flow rate of air ($\dot{m}_{a200}$) from heated SVE wells = Q_a*$\rho_{a200,24}$ = 10.243 lbm/min

4.2 Steam Vapor

4.2.1 Molecular Mass (M) = 18.015, Ref. 2.3 (Table A.10E)

4.2.2 Specific Heat Ratio (k) = 1.327, 80°F, Ref. 2.3 (Table A.10E)

4.2.3 Viscosity, saturated (μ_s) = 0.010 Cp, Ref. 2.4 (A-2)

4.2.4 Volumetric flow rate (Q_s) = 856 ft^3/min @ 200°F & 24"Hg abs., Ref. 2.2, page 6

4.2.5 Specific volume of saturated steam (v_g) = 33.631 ft^3/lbm @ 200°F & 24"Hg, Ref. 2.3 (Table A.1E)

4.2.6 Mass flow rate ($\dot{m}_s$) = Q_s/ v_g = 25.45 lbm/min (1,527 lbm/hr)

5.0 ANALYTICAL METHODS AND COMPUTATIONS

5.1 Analytical methods

5.1.1 The heat loss of the pipe and hose will be performed using standard heat transfer methodology (i.e., hollow cylinder, convection at both boundaries). The basic pipe sizes will be 2" (carbon steel & rubber hose), 4" (CPVC) and 6" (CPVC & rubber hose) SCH 40. Only piping/hoses flowing steam will be evaluated.

5.1.2 The head loss calculation will be performed using the Crane Companion software (version 3.65). The piping arrangement and general drawings (Attachments 8.1and 8.2) will be used as the source for approximate pipe/hose lengths, valves and fittings. The flow rate will be based on the results of Ref. 2.2 and the flow rate of air introduced into the system from the other SVE wells.

5.2 Computations

5.2.1 Heat loss of the pipe and hose

5.2.1.1 Pipe and hose dimensions, Ref. 2.4 (pages B16 & B17)

Pipe Size (nominal)	I.D. (inches)	O.D. (inches)
2"	2.067	2.375
4"	4.026	4.500
6"	6.065	6.625

5.2.1.2 Reynolds Number for flow conditions.

The following equation will be used to determine the Reynolds Number (Re_{in}) for the steam flow in the hose and piping.

$$Re_{in} = 6.31\left(\frac{\dot{m}_s}{I.D.\cdot \mu_s}\right)$$ Ref. 2.4, equation 3-3

The Reynolds Numbers for the steam flow in the various hose and pipe sizes are presented in **TABLE 1**.

TABLE 1

Nominal Pipe Size	$\dot{m}_s$ (lbm/hr)	I.D. (inches)	μ_s (Cp)	Re_{in} (unitless)
2"	218 note 1	2.067	0.010	66,550
4"	1,089 note 2	4.026	0.010	170,680
6"	1,525	6.065	0.010	158,660

Notes: 1. Flow rate based on seven electrodes
2. Flow rate based on five electrodes (lower zone)

The following equation will be used to determine the Reynolds Number (Re_{out21} & Re_{out96}) for the air flow around the pipe and hose. Conditions are evaluated at the film temperature (T_{f21} & T_{f96}). Results are presented in **TABLE 2**.

$$T_f = \frac{(T_w + T_\infty)}{2}$$

Where:

$T_w = 200°F$
$T_{\infty low\ temp} = 21°F$, therefore, $T_{f21} = 110.5°F$
$T_{\infty hi\ temp} = 96°F$, therefore, $T_{f96} = 148°F$

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$$Re_{out} = \frac{u_\infty O.D.}{\nu_a}$$ Ref. 2.5, equation 7-38

Where:

ν_{a21} = 1.812 x 10^{-5} m^2/s = 1.950 x 10^{-4} ft^2/s, Diffusivity of air @ 110°F, Ref. 2.5, Table B-1
ν_{a96} = 1.978 x 10^{-5} m^2/s = 2.129 x 10^{-4} ft^2/s, Diffusivity of air @ 148°F, Ref. 2.5, Table B-1
u_∞ = 5 miles per hour = 7.33 ft/s, Assumption 3.4

TABLE 2

Nominal Pipe Size	ν_{a21} (ft^2/s)	ν_{a96} (ft^2/s)	u_∞ (ft/s)	O.D., (feet)	Re_{out21}	Re_{out96}
2"	1.950 x 10^{-4}	2.129x10^{-4}	7.33	0.1979	7,442	6,817
4"	1.950 x 10^{-4}	2.129x10^{-4}	7.33	0.3750	14,103	12,917
6"	1.950 x 10^{-4}	2.129x10^{-4}	7.33	0.5521	20,763	19,017

5.2.1.3 Convective Heat Transfer Coefficient (h), BTU/(hr*ft^2*°F)

The following relationship will be used to determine h_{in} for the steam flow in the piping and hoses.

$$Nu = \frac{h_{in} \cdot I.D.}{k_s} = 0.023 \cdot Re_{in}^{0.8} \cdot Pr_s^{n}$$ Ref. 2.5, equation 8-35

Note: n = 0.3, due to process is cooling, Ref. 2.5, pg 253.

The following relationship will be used to determine h_{out} for the air flow over the piping and hoses.

$$Nu_m = 0.3 + \frac{0.62 Re_{out\,@\,temp}^{1/2} Pr_a^{1/3}}{\left[1 + (0.4/Pr_a)^{2/3}\right]^{1/4}} \left[1 + \left(\frac{Re_{out\,@\,temp}}{282{,}000}\right)^{5/8}\right]^{4/5} = \frac{h_{out} O.D.}{k_a}$$ Ref. 2.5, equation 7-40

Where (Ref. 2.5, Table B-1):

k_{a21} = 0.02748 W/(m*K) = 0.01588 BTU/(hr*ft*°F), Thermal conductivity of air @ 110°F
k_{a96} = 0.02908 W/(m*K) = 0.01681 BTU/(hr*ft*°F), Thermal conductivity of air @ 148°F
k_s = 0.0246 W/(m*K) = 0.0142 BTU/(hr*ft*°F), Thermal conductivity of steam @ 380K
Pr_{a21} = 0.704, Prandtl number of air @ 110°F
Pr_{a96} = 0.700, Prandtl number of air @ 148°F
Pr_s = 1.060, Prandtl number of steam @ 380K

The values for h_{in}, h_{out21}, and h_{out96} for the various pipe/hose sizes are presented in **TABLE 3**.

TABLE 3

Pipe size	Re_{out21}	Re_{out96}	Re_{in}	h_{out21} BTU/(hr*ft^2*°F)	h_{out96} BTU/(hr*ft^2*°F)	h_{in} BTU/(hr*ft^2*°F)
2	7,442	6,817	66,550	3.65	3.67	13.93
4	14,103	12,917	170,680	2.74	2.76	15.19
6	20,763	19,017	158,660	2.32	2.33	9.51

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5.2.1.4 Heat loss of piping and hoses

The following equation will be used to determine the heat loss per foot of pipe and hose.

$$\dot{q} = \frac{T_{\infty in} - T_{\infty out}}{(R_{\infty in} + R_{cyl} + R_{\infty out}) \cdot \frac{60\ min}{hr}}$$ Ref. 2.5, equation 4-32

Where:

$$R_{\infty in} = \frac{1}{2\pi a H h_{in}}$$

$$R_{cyl} = \frac{\ln\left(b/a\right)}{2\pi k_{pipe\ or\ hose} H}$$ Ref. 2.5, equations 4-33a, b & c

$$R_{\infty out} = \frac{1}{2\pi b H h_{out}}$$

Where;

b = ½*O.D., ft
a = ½*I.D., ft
H = length of piping or hose, ft
k_{pipe} = 52 W/(m*°C) = 30 BTU/(hr*ft*°F), Carbon Steel @ 100°C, Ref. 2.5, Table B-4
k_{CPVC} = 0.137 W/(m*°C) = 0.0792 BTU/(hr*ft*°F), CPVC @ 25°C, Attachment 8.3
k_{hose} = 0.012 W/(m*°C) = 0.00693 BTU/(hr*ft*°F), soft rubber @ 30°C, Ref. 2.5, Table B-6

Solving for $\dot{q}/H$, BTU/(ft*min), the heat loss rate per foot for the various pipe and hose sizes are presented in **TABLE 4**.

TABLE 4

Temperature = 21°F			
Material	**Nominal Pipe Size**		
	2"	**4"**	**6"**
Carbon Steel Pipe	5.20	N/A	N/A
CPVC Pipe	N/A	4.59	5.03
Rubber Hose	0.79	N/A	0.85
Temperature = 96°F			
Material	**Nominal Pipe Size**		
	2"	**4"**	**6"**
Carbon Steel Pipe	3.04	N/A	N/A
CPVC Pipe	N/A	2.67	2.92
Rubber Hose	0.46	N/A	0.50

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5.2.2 Additional heat loss due to mixing

Since the air from the non-heated SVE wells will mix with the steam vapor, the amount of air will need to be throttled to prevent exceeding the blower capacity (1000 cfm). Ref. 2.2 limits the amount of dilution air to 300 cfm, Q_a. However, the SVE wells for the non-heated zone will also be drawing air. Therefore, the air from the non-heated SVE wells in the heated zone will be limited to 100 cfm, with the remaining 200 cfm for the non-heated zone SVE wells.

The first law of thermodynamics, steady flow system, will be used to determine the heat loss of the air/steam vapor mixture.

Where:
h_{g200} = 1145.9 BTU/lbm, enthalpy of saturated steam @ 200°F, Ref.2.3, Table A.1E
h_{gf200} = 977.90 BTU/lbm, latent heat of condensation @ 200°F, Ref.2.3, Table A.1E
h_{f200} = 168.07 BTU/lbm, enthalpy of water @ 200°F, Ref.2.3, Table A.1E
h_{a60} = 124.383 BTU/lbm, enthalpy of air @ 60°F, Ref.2.3, Table A.12E
h_{a200} = 158.038 BTU/lbm, enthalpy of air @ 200°F, Ref.2.3, Table A.12E

The mass flow rate for the air ($\dot{m}_a$) is as follows (continuity equation);

$$\dot{m}_a = Q_a \cdot \rho_{a200,24} = 100\frac{ft^3}{\min} \cdot 0.04809\frac{lbm}{ft^3} = 4.81\frac{lbm}{\min}$$

Using the first law of thermodynamics, constant temperature (i.e., 200°F) the reduction in the enthalpy of the steam vapor is derived as follows.

$$\dot{q}_m = \dot{q}_s - \dot{q}_{a60\,to\,200}$$

$$\dot{m}_s h_m = \dot{m}_s h_{g200} - \dot{m}_{a60}(h_{a200} - h_{a60})$$

$$h_m = \frac{\dot{m}_s h_{g200} - \dot{m}_{a60}(h_{a200} - h_{a60})}{\dot{m}_s}$$

$$h_m = \frac{(25.45\frac{lbm}{\min} \cdot 1145.9\frac{BTU}{lbm}) - 4.81\frac{lbm}{\min}(158.038\frac{BTU}{lbm} - 124.383\frac{BTU}{lbm})}{25.45\frac{lbm}{\min}} = 1{,}139.5\frac{BTU}{lbm}$$

Note: subscripts are as follows;
m – mixture of steam and with cooler air
a – air
s – steam vapor

The change is enthalpy of the steam is 1145.9 – 1139.5 = 6.4 BTU/lbm

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5.2.3 Total heat loss prior to entering the heat exchanger inlet

Based on the piping arrangement and well heads (Attachment 8.1 & 8.2) the heat loss due to convection is as follows, TABLE 5. The mass flow rates are based on the flow rates of TABLE 1. However, the flow rate through the 4" CPVC pipe, 45 foot length, is evaluated at a flow rate of 7.24 lbm/min (i.e., 25.45 – 18.18 = 7.24 lbm/min).

TABLE 5

Nominal Pipe Size	H, ft (Approx.)	$\dot{m}, \frac{lbm}{min}$	$\dot{q}/_{H\ 21}, \frac{BTU}{ft \cdot min}$	$\dot{q}/_{H\ 96}, \frac{BTU}{ft \cdot min}$	$\dot{q}_{21}, \frac{BTU}{min}$	$\dot{q}_{96}, \frac{BTU}{min}$	$\Delta h_{21}, \frac{BTU}{lbm}$	$\Delta h_{96}, \frac{BTU}{lbm}$
2" Carbon Steel Pipe	7	3.64	5.20	3.04	36.40	21.28	10.00	5.85
2" Rubber Hose	6	3.64	0.79	0.46	4.74	2.76	1.30	0.76
4" CPVC Pipe	51	18.18	4.59	2.67	234.09	136.17	12.88	7.49
4"CPVC Pipe	45	7.24	4.59	2.67	206.55	120.15	28.53	16.60
6" CPVC Pipe	15	25.45	5.03	2.92	75.45	43.80	2.96	1.72
6" CPVC Pipe	29	25.45	5.03	2.92	145.87	84.68	5.73	3.33
6" Rubber Hose	200	25.45	0.85	0.50	170.00	100.00	6.68	3.93
						Change in Enthalpy of the steam (BTU/lbm) (line losses)	68.08	39.68
						Change in Enthalpy of the steam (BTU/lbm) (mixing losses)	6.4	6.4
						Total change is Enthalpy of steam (BTU/lbm)	74.48	46.08

5.2.4 Head loss from SVE well outlets to heat exchanger inlet

5.2.4.1 Mass Flow rates

Determination of the head loss in the piping and hoses will be based on the mass flow rates of air from the non-heated SVE wells and steam vapor/air from the heated SVE wells. The steam vapor mass flow rate will be 25.45 lbm/min steam vapor, section 4.2.6, and the heated air mass flow rate will be10.243 lbm/min, section 4.1.6, divided evenly to the SVE wells being heated (total of 35.69 lbm/min). The mass flow rate of air will be 4.81 divided evenly to the non-heated SVE wells. A review of the heating campaigns (Attachment 8.3) illustrates that either of the campaigns of the lower zone will create the greatest flow for the heated and non-heated SVE wells.

5.2.4.2 Derived inputs for Crane Companion software

5.2.4.2.1 Molecular Weights

The weighted molecular weight (M_w) of the air and steam vapor in the main header, 4" & 6" pipe/hose, is as follows:

$$M_w = M_a \frac{\dot{m}_{a60} + \dot{m}_{a200}}{\sum \dot{m}} + M_s \frac{\dot{m}_s}{\sum \dot{m}}$$ (conservation of mass)

$$M_w = 28.97 \cdot \frac{(4.81 + 10.243)}{40.503} + 18.015 \cdot \frac{25.45}{40.503} = 22.09$$

The weighted molecular weight (M_{w2}) of the air and steam vapor in the heated SVE well head pipe/hose is as follows:

$$M_{w2} = M_a \frac{\dot{m}_{a200}}{\sum \dot{m}} + M_s \frac{\dot{m}_s}{\sum \dot{m}}$$

$$M_{w2} = 28.97 \cdot \frac{10.243}{35.69} + 18.015 \cdot \frac{25.45}{35.69} = 21.16$$

5.2.4.2.2 Specific Heat Ratio (k)

The specific heat ratio for steam (assumed an ideal gas) will be as follows.

$$C_p = \left(\frac{\partial h}{\partial T}\right)_p \approx \left(\frac{\Delta h}{\Delta T}\right)_p$$

$$C_v = \left(\frac{\partial u}{\partial T}\right)_v \approx \left(\frac{\Delta u}{\Delta T}\right)_v$$

Ref. 2.3, page 110, equations 5.14 & 5.15

Where;
"h" is enthalpy,
"u" is internal energy
"T" is temperature

Evaluating at 80°F and 200°F, the following is derived (Ref. 2.3, Table A.1E).

h_{g200}	= 1145.9	BTU/lbm
h_{g80}	= 1096.4	BTU/lbm
u_{g80}	= 1037	BTU/lbm
u_{g200}	= 1074.2	BTU/lbm

$$C_p \approx \left(\frac{1145.9 - 1096.4}{200 - 80}\right)_p = 0.4125$$

$$C_v \approx \left(\frac{1074.2 - 1037}{200 - 80}\right)_v = 0.31$$

$k = C_p/C_v = 0.4125/0.31 =$ **1.331**

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5.2.4.3 Head losses

The model that will be used to arrive at the losses in the piping/hose arrangement will consist of the following:

5.2.4.3.1 Well head carbon steel piping and 7' rubber hose with steam/air (e.g., CMA 55EB & CMA 55EC, Attachment 8.1 & 8.2)

5.2.4.3.2 Well head carbon steel piping and 13' rubber hose with only air (e.g., CMA 75ED, Attachment 8.1 & 8.2)

5.2.4.3.3 52 feet - 4" CPVC pipe (Attachment 8.1), length rounded up to nearest foot.

5.2.4.3.4 30 feet – 6" CPVC pipe (Attachment 8.1), length rounded up to nearest foot.

5.2.4.3.5 200 feet- 6" Rubber hose (Attachment 8.1), length rounded to nearest foot.

The methodology will be to maintain the SVE well head flanged connections at 6"Hg vacuum (Ref. 2.1, section 2.2.1). This will be accomplished by adjusting the C_v of the custom component (i.e., throttled globe valve) of the air only SVE well until the steam/air and air only SVE well piping/hoses head losses/pressure drop are equal.

The mass flow rate for the steam/air, $(\dot{m}_{s/a})$, SVE well will be as follows:

$$\dot{m}_{s/a} = (25.45 + 10.243) \cdot \frac{1}{7} = 5.1 \frac{lbm}{\min}$$

The mass flow rate for the air only, $(\dot{m}_{a\,only})$, SVE well will be as follows:

$$\dot{m}_{a\,only} = 4.81 \cdot \frac{1}{4} = 1.2 \frac{lbm}{\min}$$

The 4" CPVC pipe will be evaluated at 29.1 lbm/min (sum of 5 steam/air and 3 air only SVE wells). The 6" CPVC pipe and the 6" rubber hose will be evaluated at 40.5 lbm/min (total mass flow rate of steam/air and air).

The head losses, in "Hg, associated with the system components identified above will provide a conservative estimate of the pressure drop from the SVE wells to the heat exchanger inlet.

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5.2.4.4 Results are presented in the following Crane Companion output files.

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                            ONE-PAGE SUMMARY

  Branch Number:                  5
  Branch Name:     carbon steel components Steam/Air

                           FLUID DESCRIPTION

  Compressible - Location Not Specified
  Spec. Heat Ratio (Cp/Cv): 1.327
  Molecular Weight:          21.16
  Specific Gravity:          0.622



                         HARDWARE DESCRIPTION

  Number of Components:         10
  Branch Inlet Diameter:     2.067 inches
  Branch Outlet Diameter:    2.067 inches

  Branch Elevational Change:  0.0 feet
  Branch K Factor:           10.10

                           FLOW DESCRIPTION

  Mass Flow Rate:             5.01 lb/min = 300.60 lb/hr
  Std Vol. Flow Rate:       89.821 SCFM
  Inlet Vol. Flow Rate:     142.31 cu ft/min = 1,064.57 US gal/min
  Inlet Velocity:           101.78 ft/sec (FPS)
  Inlet Mach No.:            0.071
  Outlet Vol. Flow Rate:    147.41 cu ft/min = 1,102.73 US gal/min
  Outlet Velocity:          105.43 ft/sec (FPS)
  Outlet Mach No.:           0.074

  Differential Pressure:      0.83 in Hg (32F) = 0.41 PSID
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FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	200.00	23.98	28.41	
Pipe, NPS 2, sched 40, 5.00'	200.00	23.98	28.41	
[5] Tee, 2" Thru Run	200.00	23.94	28.46	
Ball valve	200.00	23.78	28.64	
Globe valve, inline	200.00	23.78	28.65	
[2] Elbow, 2" 90 Thr/SW	200.00	23.25	29.30	
OUTLET	200.00	23.15	29.42	

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HARDWARE DESCRIPTION - TABLE

Branch Number: 5
Branch Name: carbon steel components Steam/Air
Number of Components: 10

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia / Pin	Out Dia / DP	Eq Lnth / HL	K Factor / In Vel
INLET	2.067		91.64	10.104
	23.98	0.83		101.784
Pipe, NPS 2, sched 40, 5.00'	2.067	2.067	5.00	0.551
	23.98	0.04		101.784
[5] Tee, 2" Thru Run	2.067	2.067	3.44	0.380
	23.94	0.15		101.974
Ball valve	2.067	2.067	0.52	0.057
	23.78	0.00		102.634
Globe valve, inline	2.067	2.067	58.56	6.457
	23.78	0.53		102.654
[2] Elbow, 2" 90 Thr/SW	2.067	2.067	5.17	0.570
	23.25	0.10		105.001
OUTLET		2.067	91.64	10.104
	23.15			105.433

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Thu Apr 21 15:10:02 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 5.01 lb/min = 300.60 lb/hr
Std Vol. Flow Rate: 89.821 SCFM
Units as follows:
Volumetric Flow Rate: cu ft/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	101.78	142.31	0.830	
Pipe, NPS 2, sched 40, 5.00'	101.78	142.31	0.045	NA
[5] Tee, 2" Thru Run	101.97	142.58	0.154	NA
Ball valve	102.63	143.50	0.005	NA
Globe valve, inline	102.65	143.53	0.532	NA
[2] Elbow, 2" 90 Thr/SW	105.00	146.81	0.095	NA
OUTLET	105.43	147.41	0.830	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Thu Apr 21 15:10:46 2005

ONE-PAGE SUMMARY

Branch Number: 4
Branch Name: 7 ft, 2" Rubber Hose

FLUID DESCRIPTION

Inlet Fluid Conditions
Spec. Heat Ratio (Cp/Cv): 1.331
Molecular Weight: 21.16
Specific Gravity: 0.731

Temperature: 200.00 Fahrenheit
Pressure: 23.15 in Hg (32F) abs = 11.37 PSIA
Density: 0.03 lb/cu ft
Specific Volume: 29.424 cu ft/lb

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 2.067 inches
Branch Outlet Diameter: 4.026 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.20

FLOW DESCRIPTION

Mass Flow Rate: 5.01 lb/min = 300.60 lb/hr
Std Vol. Flow Rate: 89.821 SCFM
Inlet Vol. Flow Rate: 147.41 cu ft/min = 1,102.73 US gal/min
Inlet Velocity: 105.43 ft/sec (FPS)
Inlet Mach No.: 0.074
Outlet Vol. Flow Rate: 147.56 cu ft/min = 1,103.81 US gal/min
Outlet Velocity: 27.82 ft/sec (FPS)
Outlet Mach No.: 0.019

Differential Pressure: 0.02 in Hg (32F) = 0.01 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Thu Apr 21 15:10:46 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	200.00	23.15	29.42	
Pipe, NPS 2, sched 40S, 7.00'	200.00	23.15	29.42	
Enlarger, 4 X 4" sud	200.00	23.09	29.49	
OUTLET	200.00	23.13	29.45	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Thu Apr 21 15:10:46 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 4
Branch Name: 7 ft, 2" Rubber Hose
Number of Components: 2

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia / Pin	Out Dia / DP	Eq Lnth / HL	K Factor / In Vel
INLET	2.067		10.89	1.200
	23.15	0.02		105.433
Pipe, NPS 2, sched 40S, 7.00'	2.067	2.067	7.00	0.658
	23.15	0.06		105.433
Enlarger, 4 X 4" sud	2.067	4.026	4.92	0.542
	23.09	-0.03		105.684
OUTLET		4.026	10.89	1.200
	23.13			27.819

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Thu Apr 21 15:10:46 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 5.01 lb/min = 300.60 lb/hr
Std Vol. Flow Rate: 89.821 SCFM
Units as follows:
Volumetric Flow Rate: cu ft/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	105.43	147.41	0.023	
Pipe, NPS 2, sched 40S, 7.00'	105.43	147.41	0.055	NA
Enlarger, 4 X 4" sud	105.68	147.76	-0.032	NA
OUTLET	27.82	147.56	0.023	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Thu Apr 21 15:11:27 2005

ONE-PAGE SUMMARY

Branch Number: 3
Branch Name: carbon steel Well Air only

FLUID DESCRIPTION

Compressible - Location Not Specified
Spec. Heat Ratio (Cp/Cv): 1.327
Molecular Weight: 28.97
Specific Gravity: 0.622

HARDWARE DESCRIPTION

Number of Components: 10
Branch Inlet Diameter: 2.067 inches
Branch Outlet Diameter: 2.067 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 317.39

FLOW DESCRIPTION

Mass Flow Rate: 1.20 lb/min = 72.00 lb/hr
Std Vol. Flow Rate: 15.714 SCFM
Inlet Vol. Flow Rate: 19.59 cu ft/min = 146.57 US gal/min
Inlet Velocity: 14.01 ft/sec (FPS)
Inlet Mach No.: 0.013
Outlet Vol. Flow Rate: 20.32 cu ft/min = 151.98 US gal/min
Outlet Velocity: 14.53 ft/sec (FPS)
Outlet Mach No.: 0.013

Differential Pressure: 0.85 in Hg (32F) = 0.42 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Thu Apr 21 15:11:27 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	60.00	24.00	16.33	
Pipe, NPS 2, sched 40, 5.00'	60.00	24.00	16.33	
[4] Tee, 2" Thru Run	60.00	24.00	16.33	
Ball valve	60.00	24.00	16.33	
Custom Component	60.00	24.00	16.33	
[2] Elbow, 2" 90 Thr/SW	60.00	23.15	16.93	
OUTLET	60.00	23.15	16.93	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Thu Apr 21 15:11:27 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 3
Branch Name: carbon steel Well Air only
Number of Components: 10

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia Pin	Out Dia DP	Eq Lnth HL	K Factor In Vel
INLET	2.067		2878.80	317.390
	24.00	0.85		14.014
Pipe, NPS 2, sched 40, 5.00'	2.067	2.067	5.00	0.551
	24.00	0.00		14.014
[4] Tee, 2" Thru Run	2.067	2.067	3.44	0.380
	24.00	0.01		14.015
Ball valve	2.067	2.067	0.52	0.057
	24.00	0.00		14.017
Custom Component	2.067	2.067	2845.73	313.743
	24.00	0.84		14.018
[2] Elbow, 2" 90 Thr/SW	2.067	2.067	5.17	0.570
	23.15	0.00		14.529
OUTLET		2.067	2878.80	317.390
	23.15			14.531

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Thu Apr 21 15:11:27 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 1.20 lb/min = 72.00 lb/hr
Std Vol. Flow Rate: 15.714 SCFM
Units as follows:
Volumetric Flow Rate: cu ft/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	14.01	19.59	0.854	
Pipe, NPS 2, sched 40, 5.00'	14.01	19.59	0.001	NA
[4] Tee, 2" Thru Run	14.01	19.59	0.005	NA
Ball valve	14.02	19.60	0.000	NA
Custom Component	14.02	19.60	0.844	NA
[2] Elbow, 2" 90 Thr/SW	14.53	20.31	0.003	NA
OUTLET	14.53	20.32	0.854	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Thu Apr 21 15:11:49 2005

ONE-PAGE SUMMARY

Branch Number: 2
Branch Name: 13 ft, 2" Rubber Hose

FLUID DESCRIPTION

Inlet Fluid Conditions
Spec. Heat Ratio (Cp/Cv): 1.400
Molecular Weight: 28.97
Specific Gravity: 1.000

Temperature: 60.00 Fahrenheit
Pressure: 23.15 in Hg (32F) abs = 11.37 PSIA
Density: 0.06 lb/cu ft
Specific Volume: 16.930 cu ft/lb

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 2.067 inches
Branch Outlet Diameter: 4.026 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 1.76

FLOW DESCRIPTION

Mass Flow Rate: 1.20 lb/min = 72.00 lb/hr
Std Vol. Flow Rate: 15.714 SCFM
Inlet Vol. Flow Rate: 20.32 cu ft/min = 151.98 US gal/min
Inlet Velocity: 14.53 ft/sec (FPS)
Inlet Mach No.: 0.013
Outlet Vol. Flow Rate: 20.32 cu ft/min = 151.99 US gal/min
Outlet Velocity: 3.83 ft/sec (FPS)
Outlet Mach No.: 0.004

Differential Pressure: 0.002287 in Hg (32F) = 0.00 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Thu Apr 21 15:11:49 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	60.00	23.15	16.93	
Pipe, NPS 2, sched 40S, 13.00'	60.00	23.15	16.93	
Enlarger, 4 X 4" sud	60.00	23.15	16.93	
OUTLET	60.00	23.15	16.93	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Thu Apr 21 15:11:49 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 2
Branch Name: 13 ft, 2" Rubber Hose
Number of Components: 2

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia / Pin	Out Dia / DP	Eq Lnth / HL	K Factor / In Vel
INLET	2.067		16.00	1.764
	23.15	0.00		14.531
Pipe, NPS 2, sched 40S, 13.00'	2.067	2.067	13.00	1.222
	23.15	0.00		14.531
Enlarger, 4 X 4" sud	2.067	4.026	4.92	0.542
	23.15	0.00		14.533
OUTLET		4.026	16.00	1.764
	23.15			3.831

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Thu Apr 21 15:11:49 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 1.20 lb/min = 72.00 lb/hr
Std Vol. Flow Rate: 15.714 SCFM
Units as follows:
Volumetric Flow Rate: cu ft/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	14.53	20.32	0.002	
Pipe, NPS 2, sched 40S, 13.00'	14.53	20.32	0.003	NA
Enlarger, 4 X 4" sud	14.53	20.32	-0.001	NA
OUTLET	3.83	20.32	0.002	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Mon Apr 25 09:41:23 2005

ONE-PAGE SUMMARY

Branch Number: 1
Branch Name: 52 ft, 4" CPVC Pipe

FLUID DESCRIPTION

Outlet Fluid Conditions
Spec. Heat Ratio (Cp/Cv): 1.331
Molecular Weight: 22.09
Specific Gravity: 0.763

Temperature: 200.00 Fahrenheit
Pressure: 11.18 PSIA
Density: 0.03 lb/cu ft
Specific Volume: 28.655 cu ft/lb

HARDWARE DESCRIPTION

Number of Components: 2
Branch Inlet Diameter: 4.026 inches
Branch Outlet Diameter: 6.065 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 2.28

FLOW DESCRIPTION

Mass Flow Rate: 29.10 lb/min = 1,746.00 lb/hr
Std Vol. Flow Rate: 499.749 SCFM
Inlet Vol. Flow Rate: 6,161.11 US gal/min
Inlet Velocity: 155.27 ft/sec (FPS)
Inlet Mach No.: 0.110
Outlet Vol. Flow Rate: 6,237.79 US gal/min
Outlet Velocity: 69.27 ft/sec (FPS)
Outlet Mach No.: 0.049

Differential Pressure: 0.28 in Hg (32F) = 0.14 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Mon Apr 25 09:41:23 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	200.00	23.05	28.30	
Pipe, NPS 4, sched 40S, 52.00'	200.00	23.05	28.30	
Enlarger, 6 X 6" sud	200.00	22.68	28.77	
OUTLET	200.00	22.77	28.66	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Mon Apr 25 09:41:23 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 1
Branch Name: 52 ft, 4" CPVC Pipe
Number of Components: 2

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia / Pin	Out Dia / DP	Eq Lnth / HL	K Factor / In Vel
INLET	4.026		46.92	2.278
	23.05	0.28		155.274
Pipe, NPS 4, sched 40S, 52.00'	4.026	4.026	52.00	1.965
	23.05	0.38		155.274
Enlarger, 6 X 6" sud	4.026	6.065	6.44	0.313
	22.68	-0.09		157.856
OUTLET		6.065	46.92	2.278
	22.77			69.272

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Mon Apr 25 09:41:23 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 29.10 lb/min = 1,746.00 lb/hr
Std Vol. Flow Rate: 499.749 SCFM
Units as follows:
Volumetric Flow Rate: US gal/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	155.27	6161.11	0.283	
Pipe, NPS 4, sched 40S, 52.00'	155.27	6161.10	0.377	NA
Enlarger, 6 X 6" sud	157.86	6263.55	-0.094	NA
OUTLET	69.27	6237.79	0.283	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Thu Apr 21 15:13:05 2005

ONE-PAGE SUMMARY

Branch Number: 6
Branch Name: 30 ft, 6" CPVC Pipe

FLUID DESCRIPTION

Outlet Fluid Conditions
Spec. Heat Ratio (Cp/Cv): 1.331
Molecular Weight: 22.09
Specific Gravity: 0.763

Temperature: 200.00 Fahrenheit
Pressure: 22.72 in Hg (32F) abs = 11.16 PSIA
Density: 0.03 lb/cu ft
Specific Volume: 28.718 cu ft/lb

HARDWARE DESCRIPTION

Number of Components: 1
Branch Inlet Diameter: 6.065 inches
Branch Outlet Diameter: 6.065 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 0.70

FLOW DESCRIPTION

Mass Flow Rate: 40.50 lb/min = 2,430.00 lb/hr
Std Vol. Flow Rate: 695.527 SCFM
Inlet Vol. Flow Rate: 1,160.54 cu ft/min = 8,681.49 US gal/min
Inlet Velocity: 96.41 ft/sec (FPS)
Inlet Mach No.: 0.069
Outlet Vol. Flow Rate: 1,163.09 cu ft/min = 8,700.57 US gal/min
Outlet Velocity: 96.62 ft/sec (FPS)
Outlet Mach No.: 0.069

Differential Pressure: 0.05 in Hg (32F) = 0.02 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Thu Apr 21 15:13:05 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	200.00	22.77	28.66	
Pipe, NPS 6, sched 40S, 30.00'	200.00	22.77	28.66	
OUTLET	200.00	22.72	28.72	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Thu Apr 21 15:13:05 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 6
Branch Name: 30 ft, 6" CPVC Pipe
Number of Components: 1

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia / Pin	Out Dia / DP	Eq Lnth / HL	K Factor / In Vel
INLET	6.065		23.59	0.696
	22.77	0.05		96.410
Pipe, NPS 6, sched 40S, 30.00'	6.065	6.065	30.00	0.696
	22.77	0.05		96.410
OUTLET		6.065	23.59	0.696
	22.72			96.622

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -4- Thu Apr 21 15:13:05 2005

FLOW DESCRIPTION - TABLE

Mass Flow Rate: 40.50 lb/min = 2,430.00 lb/hr
Std Vol. Flow Rate: 695.527 SCFM
Units as follows:
Volumetric Flow Rate: cu ft/min
Velocity: ft/sec (FPS)
Differential Pressure: in Hg (32F)

Component Name	Inl Vel	Inl Vol	DP	Exp Fact
INLET	96.41	1160.54	0.050	
Pipe, NPS 6, sched 40S, 30.00'	96.41	1160.54	0.050	NA
OUTLET	96.62	1163.09	0.050	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -1- Thu Apr 21 15:13:39 2005

ONE-PAGE SUMMARY

Branch Number: 7
Branch Name: 200 ft, 6" Rubber Hose

FLUID DESCRIPTION

Outlet Fluid Conditions
Spec. Heat Ratio (Cp/Cv): 1.331
Molecular Weight: 22.09
Specific Gravity: 0.763

Temperature: 200.00 Fahrenheit
Pressure: 22.35 in Hg (32F) abs = 10.98 PSIA
Density: 0.03 lb/cu ft
Specific Volume: 29.194 cu ft/lb

HARDWARE DESCRIPTION

Number of Components: 1
Branch Inlet Diameter: 6.065 inches
Branch Outlet Diameter: 6.065 inches

Branch Elevational Change: 0.0 feet
Branch K Factor: 5.12

FLOW DESCRIPTION

Mass Flow Rate: 40.50 lb/min = 2,430.18 lb/hr
Std Vol. Flow Rate: 695.578 SCFM
Inlet Vol. Flow Rate: 1,163.13 cu ft/min = 8,700.85 US gal/min
Inlet Velocity: 96.62 ft/sec (FPS)
Inlet Mach No.: 0.069
Outlet Vol. Flow Rate: 1,182.43 cu ft/min = 8,845.26 US gal/min
Outlet Velocity: 98.23 ft/sec (FPS)
Outlet Mach No.: 0.070

Differential Pressure: 0.37 in Hg (32F) = 0.18 PSID

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -2- Thu Apr 21 15:13:39 2005

FLUID DESCRIPTION - TABLE

Fluid: Ideal Gas

Units as follows:
Temperature: Fahrenheit
Pressure: in Hg (32F) abs
Specific Volume: cu ft/lb
Absolute Viscosity: centipoise

Component Name	Inlet T	Inlet P	Inl Vol	Inv Visc
INLET	200.00	22.72	28.72	
Pipe, NPS 6, sched 40S, 200.00'	200.00	22.72	28.72	
OUTLET	200.00	22.35	29.19	

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3] -3- Thu Apr 21 15:13:39 2005

HARDWARE DESCRIPTION - TABLE

Branch Number: 7
Branch Name: 200 ft, 6" Rubber Hose
Number of Components: 1

Units as follows:
Diameter: inches
Equivalent Length: feet
Inlet Pressure (Pin): in Hg (32F) abs
Differential Pressure (DP): in Hg (32F)
Head Loss (HL): feet
Inlet Velocity: ft/sec (FPS)

Component Name	In Dia Pin	Out Dia DP	Eq Lnth HL	K Factor In Vel
INLET	6.065		173.55	5.117
	22.72	0.37		96.625
Pipe, NPS 6, sched 40S, 200.00'	6.065	6.065	200.00	5.117
	22.72	0.37		96.625
OUTLET		6.065	173.55	5.117
	22.35			98.228

Calculation Continuation Sheet

Calculation No.	Sheet No.	Rev.
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DF DesigNet [Ver 3]              -4-          Thu Apr 21 15:13:39 2005

                        FLOW DESCRIPTION - TABLE

  Mass Flow Rate:           40.50 lb/min = 2,430.18 lb/hr
  Std Vol. Flow Rate:     695.578 SCFM
  Units as follows:
    Volumetric Flow Rate:  cu ft/min
    Velocity:  ft/sec (FPS)
    Differential Pressure:  in Hg (32F)

Component Name                      Inl Vel Inl Vol   DP     Exp Fact

INLET                                 96.62 1163.13   0.371

Pipe, NPS 6, sched 40S, 200.00'       96.62 1163.13   0.371      NA

OUTLET                                98.23 1182.43   0.371
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5.2.4.5 Total head loss

The head losses of the evaluated components are as follows:

Well steam/Air	0.83 "Hg
7 ft rubber hose	0.02 "Hg
Well air only	0.85 "Hg
13 ft rubber hose	0.0023 "Hg
52 ft, 4" CPVC pipe	0.28 "Hg
30 ft, 6" CPVC pipe	0.05 "Hg
200 ft, 6" rubber hose	0.37 "Hg

Since the wells are in parallel the total head loss will be the sum of; either well and associated hose, 52 ft CPVC pipe, 30 ft CPVC pipe and the 200 ft rubber hose. The total head loss will be approximately 1.55 "Hg.

6.0 RESULTS

6.1 The heat loss from the piping/hose arrangement will be between 46.08 and 74.48 BTU/lbm.

6.2 The head loss across the system (well head to inlet of heat exchanger) will be approximately 1.55"Hg, pressure at the inlet will need to be 22.45 "Hg absolute to provide sufficient vacuum for system.

Calculation Continuation Sheet

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7.0 CONCLUSION

7.1 The heat loss form the piping/hose arrangement will be used to determine the potential amount of condensate that will accumulate in the piping/hoses for collection tank sizing.

7.2 The SVE blower must be capable of ensuring a 22.45 "Hg absolute pressure at the inlet of the heat exchanger (pressure drop from the well head to the inlet to the heat exchanger is approximately 1.55"Hg).

8.0 ATTACHMENTS

8.1 Piping Arrangement

8.2 Well Head Configuration

8.3 *Heating Campaigns*

Calculation Continuation Sheet

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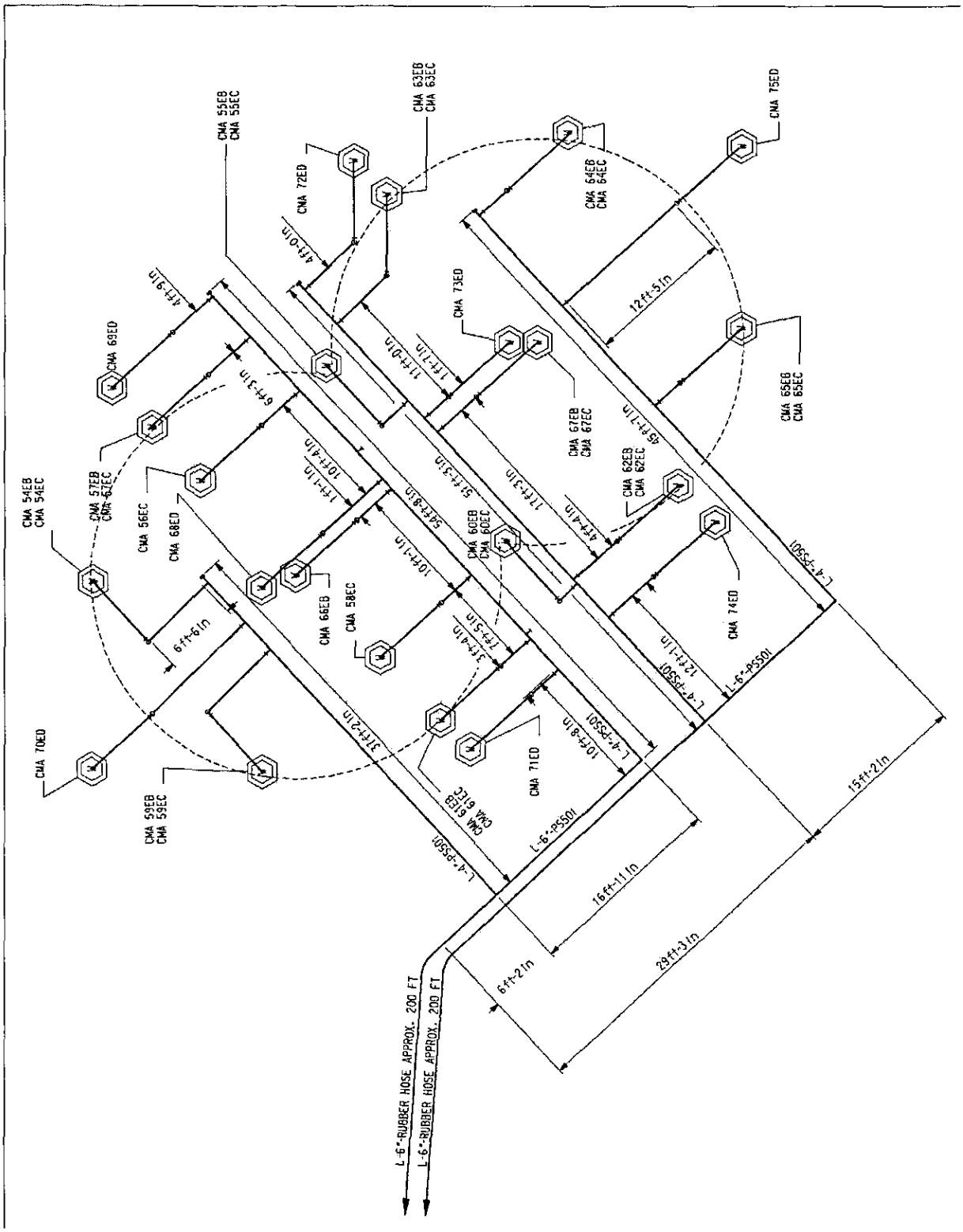
ATTACHMENT 8.1



Calculation Continuation Sheet

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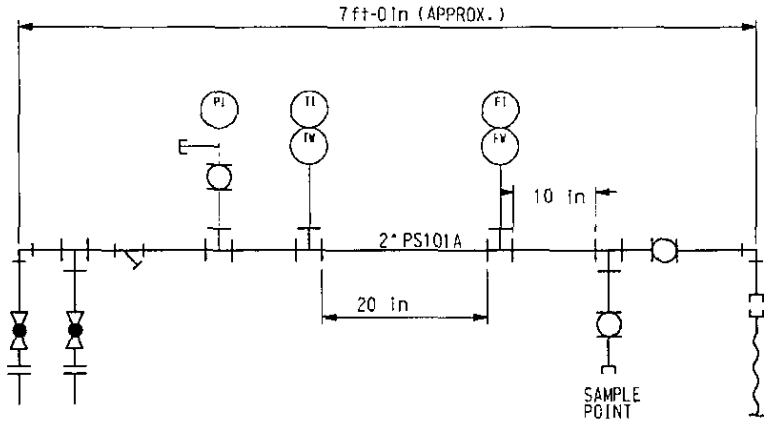
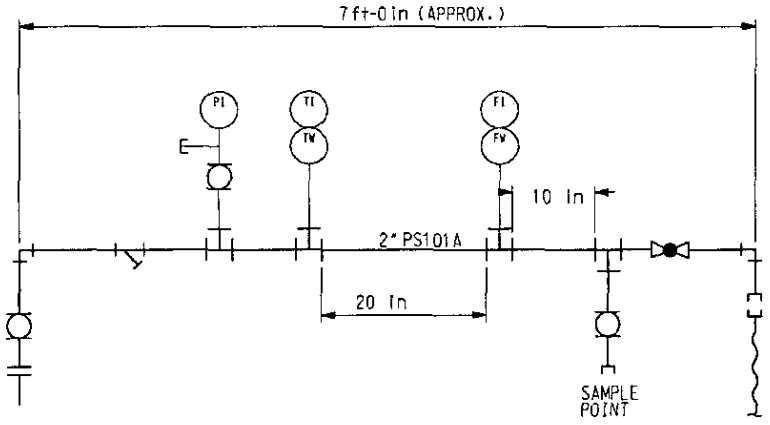
ATTACHMENT 8.2



TYPICAL FOR THE FOLLOWING EXTRACTION WELL LOCATIONS:
CMA 54EB, CMA 54EC, CMA 55EB, CMA 55EC, CMA 57EB, CMA 57EC,
CMA 59EB, CMA 59EC, CMA 60EB, CMA 60EC, CMA 61EB, CMA 61EC,
CMA 62EB, CMA 62EC, CMA 63EB, CMA 63EC, CMA 64EB, CMA 64EC,
CMA 65EB, CMA 65EC, CMA 67EB, CMA 67EC



TYPICAL FOR THE FOLLOWING EXTRACTION WELL LOCATIONS:
CMA 56EB, CMA 58EC, CMA 66EB, CMA 68ED, CMA 69ED, CMA 70ED,
CMA 71ED, CMA 72ED, CMA 73ED, CMA 74ED, CMA 75ED

Calculation Continuation Sheet

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ATTACHMENT 8.3