A-94-16
II-D-91

INDIANAPOLIS POWER & LIGHT COMPANY

June 14, 1994

Ms. Genevieve Nearmyer
U.S. EPA Region V
Air and Radiation Division (AE-18J)
77 West Jackson Boulevard
Chicago, Illinois 60604

RE: Procedure for Replacing Missing
Fuel Flow Values for E.W. Stout GT-4

Dear Ms. Nearmyer:

Indianapolis Power and Light Company (IPL) will be using Appendix D to report Sulfur Dioxide emissions from E.W. Stout's GT-4. Part 75 Appendix D 2.3.2 states, "If no oil flow rate data are available at a load recorded during the missing data period, substitute the maximum flow rate that the flowmeter can measure". IPL is seeking approval to establish the maximum flow for fuel to E.W. Stout GT-4 as the maximum amount of fuel the gas turbine is capable of burning. This issue was discussed with Mr. Pat Gimino and Ms. Margaret Sheppard prior to Pat's leave of absence from USEPA. During that conversation Pat and Margaret preliminarily agreed that the approach described below was reasonable and could be considered if further detail were provided in a letter.

Maximum oil and gas flow for GT-4 were determined using design values for peak load conditions. The results are summarized below.

FUEL	METER RANGE	CALCULATED MAXIMUM FLOW
OIL	1,500 - 15,000 gal/hr	8,731 gal/hr
GAS	0 - 138.5 - 150 in of H_2O 0 - 15.47 - ? lbs/sec 0 - 1,321 - ? kscf/hr	1,191 kscf/hr

The gas meter range contains three values on the same line. The first reading is the zero scale reading and the second reading is the flowmeter output at unit maximum load. The third reading is the maximum output of the flowmeter. To improve the accuracy over the operating range of the gas turbine, two differential pressure

transducers are used in a split range configuration. The low range transducer is typically scaled at 0 - 30 inches of water and the upper range transducer 0 - 150 inches of water. GE has scaled the gas fuel metering system so that 19.5 - 138.5 inches of water corresponds to 25% of rated base load to maximum load.

It can be seen from the table above that, the maximum meter range of the dual flow meter does exceed the amount of fuel the gas turbine can actually burn at peak load (calculated maximum flow). GT 4 is not capable of combusting fuel oil or natural gas in quantities above the maximum flow meter range.

IPL proposes that for GT-4, 125% of the calculated maximum flow rate should be substituted for fuel flow during missing data periods. This would result in the following missing flow values:

FUEL			MISSING FLOW VALUE
OIL	8,721 gal/hr x 1.25	=	10,914 gal/hr
GAS	1,191 kscf/hr x 1.25	=	1,489 kscf/hr

Copies of the calculations and supporting documents that they reference are enclosed. If you have any questions about this matter or feel additional discussion with IPL personnel would be useful, please contact me at (317) 261-8602.

Sincerely,

Lisa M. Tavormina

CALCULATIONS FOR MAXIMUM OIL FLOW

The calculations on this page use numbers supplied from three different documents. The General Electric Gas Turbine Estimated Performance sheet comes from the Operating Procedures manual supplied by the manufacturer. The box at the top of that page has design values for peak load conditions. We are using the design heat rate value for distillate. We are also using the maximum load limit contained in note 7.

Design Heat Rate (Distillate) = 10,520 btu/kwhr

Maximum Load = 115,000 kw

The second document is a fuel oil analysis performed by the Institute of Gas Technology on a sample taken at our combustion turbine. We are using the specific gravity and the gross heating values from the report.

Specific Gravity at 60/60 degf = .847

Heating Value (Gross) = 19,640 btu/lb

The third document is a conversion table to change specific gravity to density.

Specific Gravity (.847) = 7.055 lbs/gal

The first calculation multiplies unit maximum load by design heat rate at maximum load to get the amount of heat energy burned per hour.

$$115{,}000\ \text{kw} \times 10{,}520\ \frac{\text{btu}}{\text{kwhr}} = 1{,}209{,}800{,}000\ \frac{\text{btu}}{\text{hr}}$$

Next we divided the heat energy burned per hour at maximum load by the heating value (gross) of oil to get the number of pounds of oil burned per hour at maximum load.

$$\frac{1{,}209{,}800{,}000\ \text{btu/hr}}{19{,}640\ \text{btu/lb}} = 61{,}599\ \frac{\text{lb}}{\text{hr}}$$

The third calculation divides the pounds of oil burned per hour at maximum load by the oil density to get the amount of oil burned at maximum load in gallons per hour.

$$\frac{61{,}599\ \text{lb/hr}}{7.055\ \text{lb/gal}} = 8{,}731\ \frac{\text{gal}}{\text{hr}}$$

CALCULATIONS FOR MAXIMUM GAS FLOW

The calculations on this page use numbers supplied from two different documents. The General Electric Gas Turbine Estimated Performance sheet comes from the Operating Procedures manual supplied by the manufacturer. The box at the top of that page has design values for peak load conditions. We are using the design heat rate value for natural gas. We are also using the maximum load limit contained in note 7.

Design Heat Rate (Natural Gas) = 10,450 btu/kwhr

Maximum Load = 115,000 kw

The second document is a fuel gas analysis performed by the Institute of Gas Technology on a sample taken at our combustion turbine. We are using the gross heating value (saturated) from the report.

Gross Heating Value (Saturated) = 1,009 btu/scf

The first calculation multiplies unit maximum load by design heat rate at maximum load to get the amount of heat energy burned per hour.

$$115{,}000 \text{ kw} \times 10{,}450 \frac{\text{btu}}{\text{kwhr}} = 1{,}201{,}750{,}000 \frac{\text{btu}}{\text{hr}}$$

The second calculation divides the heat energy burned per hour at maximum load by the gross heating value (saturated) of gas and multiplies by a conversion factor to get the amount of gas burned at maximum load in thousands of standard cubic feet per hour.

$$\frac{1{,}201{,}750{,}000 \text{ btu/hr}}{1{,}009 \text{ btu/scf}} \times \frac{1 \text{ kscf}}{1{,}000 \text{ scf}} = 1{,}191 \frac{\text{kscf}}{\text{hr}}$$

GAS METER RANGE CONVERSION OF LBS/SEC TO KSCF/HR

$$15.47 \frac{\text{lb}}{\text{sec}} \times 379.5 \frac{\text{scf}}{\text{lb mole}} \times \frac{1 \text{ lb mole}}{16 \text{ lb}} \times 3600 \frac{\text{sec}}{\text{hr}} = 1{,}320{,}944 \frac{\text{scf}}{\text{hr}}$$

$$1{,}320{,}944 \frac{\text{scf}}{\text{hr}} \times \frac{1}{1000} \frac{\text{kscf}}{\text{scf}} = 1{,}321 \frac{\text{kscf}}{\text{hr}}$$

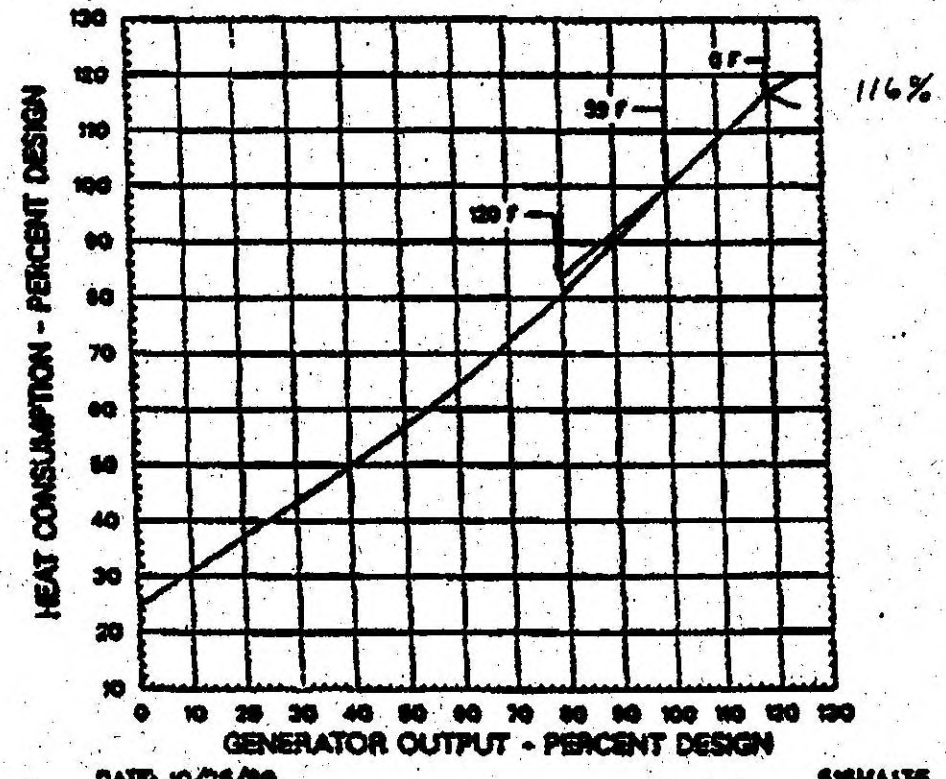
GENERAL ELECTRIC MODEL PG7111(EA) GAS TURBINE
ESTIMATED PERFORMANCE - CONFIGURATION: NATURAL GAS & DISTILLATE

Compressor Inlet Conditions 59 F (15.0 C), 60% Rel. Humidity
Atmospheric Pressure 14.7 psia (1.013 bar)

FUEL			NATURAL GAS		DISTILLATE	
DESIGN OUTPUT	kW		90200		88720	
DESIGN HEAT RATE (LHV)	Btu	(kJ)/kWh	10450	(11029)	10520	(11100)
DESIGN HEAT CONS (LHV)	Btu	(kJ)/h	942.8	(994.4)	933.3	(984.7)
DESIGN EXHAUST FLOW	lb/h	(kg)/h	2353	(1067)	2359	(1070)
MODE: PEAK LOAD						PPB 040486

NOTES:
1. Altitude correction on curve 416HA662 REV A
2. Ambient temperature correction on curve 516HA137
3. Effect of modulated IGV's on exhaust flow and temp. on curve 516HA129
4. Air cooled generator - 7A6
5. Humidity correction on curve 498HA697 REV 0 - all performance calculated with specific humidity of .0064 or less so as not to exceed 100% relative humidity.
6. Plant performance is measured at the generator terminals and includes allowances for excitation power, shaft driven auxiliaries, and 2.5 in. H20 (6.2 mbar) inlet and 5.5 in. H20 (13.7 mbar) exhaust pressure drops.
7. Maximum load limit 115,000 kW.
8. Additional pressure drop effects:

	Effect on Output	Effect on Heat Rate	Effect on Exhaust Temp.
4 in. H20 (10.0 mbar) inlet	-1.42	0.45	1.9 F (1.1 C)
4 in. H20 (10.0 mbar) exhaust	-0.42	0.42	1.9 F (1.1 C)



DATE: 10/25/89
DA JAQUEWAY

S16HA136

19650 Btu/lb

57,000 lb/Hr

80.17 gal/HR

134.65 gpm

Page 3 IGT ANALYTICAL REPORT Work Order # 94-04-001
Received: 04/01/94 Results by Sample

PLE ID Fuel oil sample FRACTION 02A TEST CODE OIL NAME Petroleum analysis
Date & Time Collected 03/25/94 Category

PHASE SEPARATION	Vt. (g)	%
Total Sample	NR	
Oil		
Solids		
Water		
Solvent		

OIL FRACTION

Viscosity (Kinematic)	NR	
(Saybolt)	NR	
Pour Point (°F)	NR	
Specific Gravity by Hydrometer (Degrees API at 60°F)	35.9	
(Specific Gravity at 60/60°F)	0.847	
Ash % (ASTM)		(Normalized)
(from OM detn.)	0.00	
Carbon %	86.87	86.45
Hydrogen %	13.57	13.50
Nitrogen %	0.02	
Sulfur %	0.03	
Oxygen %		
Total %	100.49	100.00
Carbon to Hydrogen Ratio	6.40	
Heating Value (BTU/lb) (Gross)	19440	
(Net)	18610	
Gross Enthalpy (BTU/lb)	(-) 19420	

Note: "NR" = Not Determined

Weight-Volume Relationships . . . continued

Degrees API

Degrees API	Specific gravity at 60/60 °F	Pounds Per Gallon	Gallons Per Pound
18.0	.9465	7.881	.1269
18.1	.9459	7.877	.1270
18.2	.9452	7.871	.1270
18.3	.9446	7.866	.1271
18.4	.9440	7.861	.1272
18.5	.9433	7.856	.1273
18.6	.9427	7.851	.1274
18.7	.9421	7.846	.1275
18.8	.9415	7.841	.1275
18.9	.9408	7.835	.1276
19.0	.9402	7.830	.1277
19.1	.9396	7.825	.1278
19.2	.9390	7.820	.1279
20.0	.9342	7.780	.1286
20.1	.9336	7.774	.1287
20.2	.9330	7.769	.1288
20.3	.9324	7.764	.1288
20.4	.9318	7.759	.1289
20.5	.9312	7.755	.1290
20.6	.9307	7.750	.1291
20.7	.9301	7.745	.1291
20.8	.9295	7.740	.1292
20.9	.9289	7.735	.1293
21.0	.9284	7.731	.1293
21.1	.9278	7.726	.1294
21.2	.9272	7.722	.1295
22.0	.9224	7.682	.1302
22.1	.9219	7.678	.1303
22.2	.9214	7.674	.1303
22.3	.9208	7.669	.1304
22.4	.9203	7.665	.1305
22.5	.9198	7.661	.1305
22.6	.9193	7.657	.1306
22.7	.9188	7.653	.1306
22.8	.9182	7.649	.1307
22.9	.9177	7.645	.1308
23.0	.9172	7.641	.1309
23.1	.9167	7.636	.1309
23.2	.9161	7.632	.1310
23.3	.9156	7.628	.1310
23.4	.9151	7.624	.1311
23.5	.9146	7.620	.1312
23.6	.9141	7.616	.1312
23.7	.9136	7.612	.1313
23.8	.9131	7.608	.1314
23.9	.9126	7.604	.1315
24.0	.9121	7.600	.1315
24.1	.9116	7.596	.1316
24.2	.9111	7.592	.1317
24.3	.9106	7.588	.1317
24.4	.9101	7.584	.1318
24.5	.9096	7.580	.1319
24.6	.9091	7.576	.1320
24.7	.9086	7.572	.1320
24.8	.9081	7.568	.1321
24.9	.9076	7.564	.1322
25.0	.9042	7.536	.1328
25.1	.9036	7.524	.1329
25.2	.9030	7.519	.1330
25.3	.9024	7.514	.1331
25.4	.9018	7.509	.1332
25.5	.9012	7.505	.1333
25.6	.9007	7.500	.1333
25.7	.9001	7.496	.1334
25.8	.8996	7.491	.1335
25.9	.8990	7.486	.1336
26.0	.8984	7.481	.1337
26.1	.8978	7.476	.1338
26.2	.8972	7.472	.1338
32.0	.8684	7.208	.1388
32.1	.8649	7.202	.1389
32.2	.8644	7.198	.1389
32.3	.8639	7.193	.1390
32.4	.8633	7.188	.1391
32.5	.8628	7.184	.1392
32.6	.8623	7.180	.1393
32.7	.8618	7.176	.1394
32.8	.8612	7.171	.1395
32.9	.8607	7.167	.1396
33.0	.8602	7.163	.1396
33.1	.8597	7.158	.1397
33.2	.8591	7.153	.1398
39.9	.8259	6.910	.1447
40.0	.8254	6.906	.1448
40.1	.8249	6.902	.1449
40.2	.8245	6.898	.1450
40.3	.8240	6.894	.1451
40.4	.8235	6.890	.1451
40.5	.8230	6.886	.1452
40.6	.8225	6.882	.1453
40.7	.8220	6.878	.1454
40.8	.8215	6.874	.1455
40.9	.8210	6.870	.1456
41.0	.8205	6.866	.1456
41.1	.8200	6.862	.1457
41.2	.8195	6.858	.1458
41.3	.8190	6.854	.1459