TOTALFLOW
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NX19 Supercompressibility Equation using Fixed FtFp

Totalflow Technical Bulletin

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Introduction

We have recently become aware of some issues related to proper configuration of Totalflow flow computers, when using NX19 for Fpv (supercompressibility). This document will describe these issues and how they are related.

NX19 Overview

An example program for computing NX19 is depicted in Appendix 1. Observing the example, you see that the first bit of logic and math is designed to compute ft and fp using one of two possible methods. The NX19 standard documents at least three possible methods for computing ft and fp.

- Gravity Method
  (Standard Method) generally the default method for natural gas with Specific Gravity less than 0.75, CO2 mol% less than 15% and N2 mol% less than 15%. User Inputs are Specific Gravity, mol%CO2 and mol%N2.

- Methane Gravity Method
  User Inputs are Specific Gravity, mol%CO2 and mol%N2 and mol%C1.

- Analysis Method
  User Inputs are full analysis mol%'s.

The NX19 standard implies that the Gravity Method is the standard method, but offers no clear guidance on which method to use when the standard gravity method is not applicable. In fact, some proponents of AGA8 say that NX19 should not be used when outside the gravity method ranges. Generally the choice is left to the user, who is most familiar with the details of each measurement situation.

In the Appendix 1 example, either the Gravity Method or the Methane Gravity Method are chosen, based in the values for Specific Gravity, CO2 and N2. Once ft and fp are computed, the remainder (and majority) of nx19 is exactly the same.

History of Totalflow Implementations for NX19

Earliest Implementation

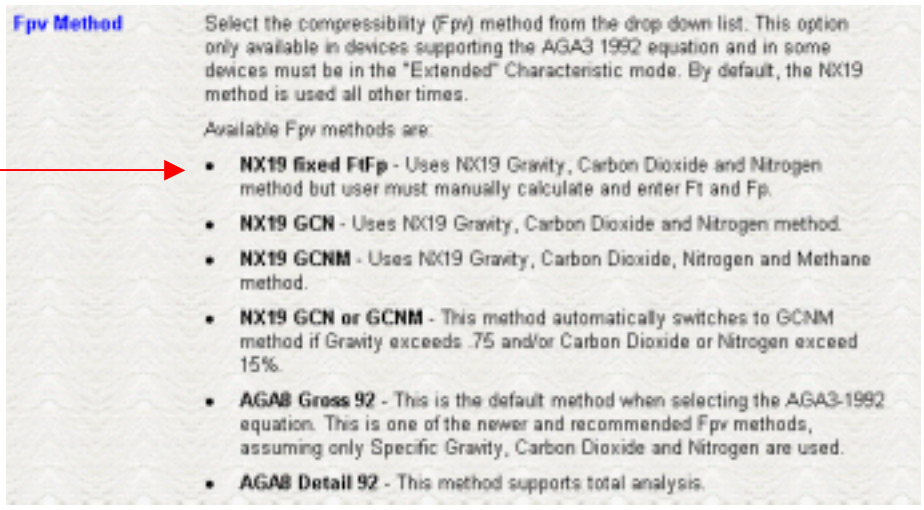
Totalflow's earliest flow computers expected ft and fp to be provided from the external configuration software (PCCU or CCU). Having ft and fp, the flow computer only needed AP (absolute pressure) and TF (flowing temperature) to compute the remainder of (and majority of) NX19.

Totalflow's earliest PCCU and CCU implementations computed ft and fp using the standard gravity method Gravity, CO2 and N2 were within acceptable limits. Otherwise the user was asked to enter ft and fp.

It became clear that the industry did not know what entries to make for ft and fp, so PCCU and CCU were updated to support the methane gravity method.

Later Implementation
At the same time Totalflow implemented AGA3-1992 and AGA8 (turbo card and newer) we also reviewed the older design and made several changes. These changes included, but were not limited to

- Allow periodic calculations to run faster than once per hour (up to once per minute)
- Allow periodic data logs to run faster than once per hour (up to once per minute)
- Remove linkage between calculation period and logging period (for example, can calc once per minute and log once per hour)
- Allow periodic averages to be either linear or square root averages
- When using the 1992 equation, include flowing temperature in the extension calculation and integration each second.
- Implement DB2, to increase the number of variables maintained for the hourly (now called log period) and the daily records. These new variables included such things as *Integrated Extension, Number of seconds in period, number of flow seconds in period, quantity Energy for period, more alarms and statistics.*
- Even though DB2 was now the native database inside the flow computer, in order to support backward compatibility throughout a transition period (we figure on a couple years), the flow computer was programmed to understand the old DB1 data collection commands and to “reformat” it’s native DB2 format into a backward compatible DB1 format at data transmission time.
- Within the flow computer, compute all of NX19, including ft and fp, thus not requiring the user to understand and derive values for ft and fp.
    - The choices for Fpv that we made available to the user at that time, included the following list taken from our PCCU help file….



Over the years, it had become clear to us that most users would rather not bother with deciding about ft and fp, so we put the math inside the flow computer. We also saw a significant shift to AGA8 and thought most people would move that way.

Although we thought a very small number of people (and maybe none) would actually want to manually enter an ft and fp, we allowed for that option, just in case an existing Totalflow customer had developed that practice for measurement sites that operated outside the Standard Gravity Method.

NX19 fixed FtFp

- As was stated earlier, these flow computers were designed to bridge the gap to allow our customers to navigate transitions between AGA385/AGA392 and DB1/DB2. For that reason, the flow computers were supplied from our factory in "backward compatible mode" with a "Standard Characteristic File" that operated like the predecessor flow computers. Since this older Characteristic File new nothing of all the new changes, in order to access those changes, the user needed to switch to the "Extended Characteristic File". This was done with a simple command from PCCU. After this switch, the many new options were made available.

- **DOS PCCU (DOS Laptop, Paravant and FS2)**
  At this time, there were also significant design changes in PCCU (still DOS) and CCU (now WinCCU) to support these big changes; not the least of which were presenting different menus to the user based on whether the flow computer was an older 6600 device or was a newer device set up for "Standard Characteristic File" (to emulate 6600) or "Extended Characteristic File". (to provide new features).

  The (DOS Laptop Version or Paravant and then ultimately the FS2) was required to access the newer features, but the older PCCU (White Husky) would work with flow computers as supplied from the factory (Standard Characteristic File).

  Regarding ft and fp for NX19;

- The DOS Laptop or FS2 software computed ft and fp for NX19 when interfaced to an older flow computer or a flow computer using “Standard Characteristic File”.

- ***Once switched to “Extended Characteristic File” however, the logic switched to work as described in the “PCCU32 Laptop Help File excerpt shown above”. That is PCCU did not compute ft and fp. It presumed that either (a) the flow computer would compute ft and fp or (b) the user would manually enter ft and fp.***

- **PCCU32, Windows PCCU**

  Sometime after this, Totalflow ported the DOS laptop functionality to the 32 bit Windows environment (PCCU32). During that port of software, a piece of logic was inadvertently left behind and this fact laid dormant for several years until discovered just recently.

  In summary, PCCU32 never computes ft and fp for NX19. It reads ft and fp from the flow computer and it allows the user to manually enter ft and fp, but it does not compute ft and fp. When using “Extended Characteristic File” format the user can and should configure the flow computer to compute ft and fp. Otherwise, if not entered manually or not updated using WinCCU, the ft and fp will not be altered.

  This can affect the value for Fpv, the magnitude of which relies on several factors.

- **WinCCU**
  We believe that WinCCU has always computed ft and fp for most configurations of flow computers. There is one case in which WinCCU did not. That case being “Extended Characteristic File” in conjunction with old protocol (DB1/non-packet) transactions.

In summary

What we know about how the existing software acts.

PCCU Product	**6600’s (pre turbo cards)**	**Turbo, CB180 and 6400s configured as “Standard Characteristic File”**	**Turbo, CB180 and 6400s configured as “Extended Characteristic File”**
FS2	Calcs & Sends Ft & Fp	Calcs & Sends Ft & Fp	Does not Calc, but Sends Ft & Fp
PCCU32	Does not Calc, but sends Ft & Fp	Does not Calc, but sends Ft & Fp	Does not Calc, but sends Ft & Fp
WinCCU	Calcs & Sends Ft & Fp	Calcs & Sends Ft & Fp	Calcs & Sends Ft & Fp for new protocol Does not calc, but sends for old protocol

FtFp Events and Audit Trail Validity

For any flow computer relying on ft and fp from an external source (either older flow computers or newer flow computers configured to use Fixed ft and Fixed fp) the audit trail is preserved in that current ft and fp are shown in the "Characteristic File" and events are logged anytime ft and fp are changed.

For any flow computer configured to compute ft and fp, one merely need to check the configuration to determine which method is used. When configured to allow auto selection of the method (NX19 GCN or GCNM) a flag is set by the flow computer in each log period to define which method was chosen by the flow computer.

Magnitude of Error if ft and fp are not properly computed

Because Fpv depends on pressure, temperature and some composition data, it is not possible to predict this magnitude in a single generalized statement. However, to provide some guidance, Appendix 2 contains three different tables showing Fpv as a function of pressure and temperature for a given Specific Gravity, CO2, N2 and in one case C1.

For each pressure and temperature, three variables are presented.

(1) Actual NX19 Fpv using proper ft and fp
(2) NX19 assuming ft and fp are 1.0 in all cases (chosen because this is the cold start default for ft an fp)
(3) Percent difference between the two. This percent translates directly to a percent difference in the resulting flow rate, and therefore volume.

Recommendations

We recommend that

- Define how flow computers are configured regarding characteristic file (Standard or Extended)
- Define how flow computers are configured for Fpv
- Define if flow computer analysis and gravity is normally configured from PCCU or WinCCU
- If PCCU then define if flow computer is configured using
    - White Husky
    - FS2
    - DOS Laptop
    - PCCU32
- If PCCU32 then
    - Determine how best to update ft and fp in those flow computers

Totalflow Software that can help

- A new version of PCCU32 software is released and available that will compute ft and fp during configuration
- WinCCU always has and can continue to be used to compute ft and fp during configuration
- Totalflow has enhanced WinCCU in version 5.16 to parse through archive files and report meters using NX19, the ft and fp values and if they are correct
- Upgrade of WinCCU spreadsheet utility that to compute and send ft and fp on spreadsheet download of analysis and gravity data. This utility within WinCCU 5.16 is a very efficient method to (1) upload spreadsheet files from all flow computers on remote links, (2) download spreadsheet file to all flow computers on remote links. No intervening changes are necessary.

  When spreadsheet file is uploaded it will construct a csv file for all Ids with their current analysis an gravity configuration. Once constructed, the user simply reverses the process and downloads the same data, only now, the ft and fp will also be computed and sent down to the flow compouters.

Appendix 1 – NX19 Program Segment

```
*-----------------------------------------------------------------------*/
/* NX-19 supercompressibility calculation program (for up to 1500 psia)  */
/*-----------------------------------------------------------------------*/

double fpv_calc (ap, temp, grav, co2, n2, c1)
double  ap,                     /* absolute pressure */
        temp,                   /* flowing temperature */
        grav,                   /* gravity */
        co2,                    /* carbon dioxide mol fraction */
        n2,                     /* nigrogen mol fraction */
        c1;                     /* methane mol fraction */
{
double  nx19fpv;
double  pc, tc, ft, fp;
double  padj, tadj;
double  pii, tau;
double  m, n, b1, b2, e, e1, e34exp, d;
double  s1;
double   mc, mn;


    if ((grav > 0.75) | (co2 > 0.15) | (n2 > 0.15))
        {
        pc = 891.11 - 172.56 * grav + 443.04 * co2 - 232.23 * n2 - 122.52 * c1;
        fp = 671.4 / pc;
        tc = 327.77 + 214.82 * grav - 144.12 * co2 - 319.52 * n2 - 102.78 * c1;
        ft = 359.46 / tc;
        }
    else
        {
        mc = co2 * 100.0;           /* convert mol fraction co2 to mol percent */
        mn = n2 * 100.0;            /* convert mol fraction n2 to mol percent */
        fp = 156.47 / (160.8 - 7.22 * grav + (mc - 0.392 * mn));
        ft = 226.29 / (99.15 + 211.9 * grav - (mc + 1.681 * mn));
        }

    padj = (ap - 14.7) * fp;
    tadj = ((tf + 460.0) * ft) - 460.0;

    pii = (padj + 14.7) / 1000.0;
    tau = (tadj + 460.0) / 500.0;

/*    CCU and New FCU C-Code clip pii and tau to valid NX19 ranges of operation */
      if (fp < 0.00001) fp = 1.0;
      if (ft < 0.00001) ft = 1.0;
      if (tau < 0.84)   tau = 0.84;
      if (pii < 0.0)    pii = 0.0;


    m = 0.0330378 * pow(tau, -2.0) - 0.0221323 * pow(tau, -3.0);
    m += 0.0161353 * pow(tau, -5.0);

    n = 0.265827 * pow(tau, -2.0) + 0.0457697 * pow(tau, -4.0);
    n = (n - 0.133185 * pow(tau, -1.0)) / m;

    b2 = (3.0 - m * pow(n, 2.0)) / (9.0 * m * pow(pii, 2.0));
```

Methane Gravity Method for ft and fp

Standard Gravity Method for ft and fp

```
    if (tau >= 1.09)
        {
        e = 1.0 - 0.00075 * pow(pii, 2.3) * exp(-20.0 * (tau-1.09));
        s1 = pow((2.17 + 1.4 * (pow((tau-1.09), 0.5) - pii)), 2.0);
        e -= 0.0011 * pow((tau - 1.09), 0.5) * pow(pii, 2.0) * s1;
        }
    else if (pii < 1.3)
        {
        e = 1.0 - 0.00075 * pow(pii, 2.3) * (2.0 - (exp(-20.0 *(1.09 - tau))));
        e -= 1.317 * pow((1.09-tau), 4.0) * pii * (1.69 - pow(pii, 2.0));
        }
    else
        {
        if (tau >= 0.88)
            {
            e34exp = 1.25;
            }
        else
            {
            e34exp = 1.25 + 80.0 * (pow((0.88-tau), 2.0));
            }

        e = 1.0 - 0.00075 * pow(pii, 2.3) * (2.0 - exp(-20.0 * (1.09-tau)));
        e1 = 200.0 * pow((1.09-tau), 6.0) - 0.03249 * (1.09-tau);
        e1 += 2.0167 * pow((1.09-tau), 2.0) - 18.028 * pow((1.09-tau), 3.0);
        e1 += 42.844 * pow((1.09-tau), 4.0);
        e1 *= 0.455;
        e1 *= (pii - 1.3) * (1.69 * pow(2.0, e34exp) - pow(pii, 2.0));
        e += e1;
        }

    b1 = (9.0 * n - 2.0 * m * pow(n, 3.0)) / (54.0 * m * pow(pii, 3.0));
    b1 -= e / (2.0 * m * pow(pii, 2.0));

    d = b1 + (pow((pow(b1, 2.0) + pow(b2, 3.0)), 0.5));
    d = pow(d, (1.0/3.0));

    fpv = (b2 / d) - d + (n / (3 * pii));
    fpv = pow(fpv, 0.5);
    fpv /= (1.0 + (0.00132 / pow(tau, 3.25)));

    return (fpv);
}
```

Appendix 2 – Tables for NX19 Comparisons

NX19 TABLE - Gravity Method

PRESSURE PSIA	TEMPERATURE DEG F								
	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
100.00	1.007225	1.006989	1.006762	1.006543	1.006332	1.006128	1.005932	1.005743	1.005558
100.00	1.007225	1.006989	1.006762	1.006543	1.006332	1.006128	1.005932	1.005743	1.005558
100.00	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%	0.00000%
200.00	1.015908	1.015373	1.014859	1.014364	1.013889	1.013431	1.012992	1.012569	1.012153
200.00	1.015908	1.015373	1.014859	1.014364	1.013888	1.013431	1.012992	1.012569	1.012153
200.00	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%	0.00002%
300.00	1.024806	1.023944	1.023118	1.022326	1.021566	1.020837	1.020138	1.019467	1.018803
300.00	1.024805	1.023944	1.023118	1.022326	1.021566	1.020837	1.020138	1.019467	1.018803
300.00	0.00003%	0.00003%	0.00003%	0.00003%	0.00003%	0.00003%	0.00003%	0.00002%	0.00002%
400.00	1.033904	1.032689	1.031526	1.030413	1.029348	1.028329	1.027353	1.026419	1.025494
400.00	1.033904	1.032688	1.031525	1.030413	1.029348	1.028328	1.027353	1.026419	1.025494
400.00	0.00004%	0.00004%	0.00004%	0.00004%	0.00004%	0.00004%	0.00003%	0.00003%	0.00003%
500.00	1.043187	1.041587	1.040061	1.038604	1.037213	1.035884	1.034616	1.033405	1.032206
500.00	1.043186	1.041587	1.040060	1.038603	1.037212	1.035884	1.034616	1.033404	1.032205
500.00	0.00006%	0.00005%	0.00005%	0.00005%	0.00005%	0.00005%	0.00004%	0.00004%	0.00004%
600.00	1.052627	1.050614	1.048697	1.046872	1.045134	1.043479	1.041902	1.040400	1.038916
600.00	1.052627	1.050613	1.048696	1.046871	1.045134	1.043478	1.041901	1.040399	1.038915
600.00	0.00007%	0.00006%	0.00006%	0.00006%	0.00006%	0.00005%	0.00005%	0.00005%	0.00005%
700.00	1.062192	1.059733	1.057400	1.055185	1.053080	1.051080	1.049180	1.047375	1.045598
700.00	1.062191	1.059733	1.057399	1.055184	1.053079	1.051080	1.049180	1.047374	1.045597
700.00	0.00008%	0.00008%	0.00007%	0.00007%	0.00007%	0.00006%	0.00006%	0.00006%	0.00006%
800.00	1.071835	1.068903	1.066128	1.063501	1.061011	1.058652	1.056416	1.054296	1.052220
800.00	1.071834	1.068902	1.066128	1.063500	1.061011	1.058651	1.056415	1.054295	1.052219
800.00	0.00009%	0.00009%	0.00008%	0.00008%	0.00007%	0.00007%	0.00007%	0.00007%	0.00006%
900.00	1.081498	1.078067	1.074830	1.071772	1.068882	1.066150	1.063567	1.061125	1.058746
900.00	1.081497	1.078066	1.074829	1.071771	1.068881	1.066149	1.063566	1.061124	1.058745
900.00	0.00010%	0.00010%	0.00009%	0.00009%	0.00008%	0.00008%	0.00008%	0.00007%	0.00007%
1000.00	1.091110	1.087160	1.083442	1.079940	1.076639	1.073525	1.070589	1.067820	1.065138
1000.00	1.091109	1.087159	1.083441	1.079939	1.076638	1.073524	1.070588	1.067819	1.065137
1000.00	0.00011%	0.00010%	0.00010%	0.00009%	0.00009%	0.00009%	0.00008%	0.00008%	0.00007%

Gravity : 0.60000
N2 : 0.00000
CO2 : 0.00000
C1 : NA
Ft : 1.00000
Fp : 1.00000

Appendix 2 – Tables for NX19 Comparisons

NX19 TABLE - Gravity Method

PRESSURE PSIA	TEMPERATURE DEG F								
	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
100.00	1.008557	1.008287	1.008026	1.007774	1.007530	1.007295	1.007068	1.006849	1.006637
100.00	1.007225	1.006989	1.006762	1.006543	1.006332	1.006128	1.005932	1.005743	1.005558
100.00	0.13207%	0.12870%	0.12540%	0.12214%	0.11895%	0.11583%	0.11277%	0.10978%	0.10714%
200.00	1.018955	1.018332	1.017733	1.017156	1.016600	1.016065	1.015549	1.015053	1.014574
200.00	1.015908	1.015373	1.014859	1.014364	1.013888	1.013431	1.012992	1.012569	1.012153
200.00	0.29896%	0.29061%	0.28246%	0.27451%	0.26675%	0.25919%	0.25183%	0.24466%	0.23866%
300.00	1.029743	1.028728	1.027753	1.026817	1.025918	1.025054	1.024223	1.023426	1.022659
300.00	1.024805	1.023944	1.023118	1.022326	1.021566	1.020837	1.020138	1.019467	1.018803
300.00	0.47949%	0.46502%	0.45100%	0.43739%	0.42419%	0.41137%	0.39892%	0.38683%	0.37703%
400.00	1.040926	1.039473	1.038081	1.036749	1.035472	1.034249	1.033076	1.031952	1.030874
400.00	1.033904	1.032688	1.031525	1.030413	1.029348	1.028328	1.027353	1.026419	1.025494
400.00	0.67455%	0.65265%	0.63154%	0.61117%	0.59149%	0.57247%	0.55406%	0.53623%	0.52197%
500.00	1.052499	1.050558	1.048706	1.046937	1.045247	1.043632	1.042088	1.040612	1.039200
500.00	1.043186	1.041587	1.040060	1.038603	1.037212	1.035884	1.034616	1.033404	1.032205
500.00	0.88483%	0.85397%	0.82439%	0.79600%	0.76872%	0.74244%	0.71711%	0.69264%	0.67307%
600.00	1.064450	1.061967	1.059605	1.057358	1.055217	1.053178	1.051233	1.049378	1.047608
600.00	1.052627	1.050613	1.048696	1.046871	1.045134	1.043478	1.041901	1.040399	1.038915
600.00	1.11071%	1.06914%	1.02955%	0.99176%	0.95561%	0.92096%	0.88767%	0.85561%	0.82974%
700.00	1.076749	1.073667	1.070747	1.067977	1.065347	1.062849	1.060474	1.058214	1.056064
700.00	1.062191	1.059733	1.057399	1.055184	1.053079	1.051080	1.049180	1.047374	1.045597
700.00	1.35201%	1.29783%	1.24655%	1.19788%	1.15156%	1.10735%	1.06503%	1.02441%	0.99113%
800.00	1.089348	1.085610	1.082081	1.078745	1.075589	1.072600	1.069766	1.067078	1.064526
800.00	1.071834	1.068902	1.066128	1.063500	1.061011	1.058651	1.056415	1.054295	1.052219
800.00	1.60777%	1.53900%	1.47431%	1.41325%	1.35542%	1.30047%	1.24807%	1.19792%	1.15612%
900.00	1.102173	1.097723	1.093538	1.089597	1.085880	1.082370	1.079053	1.075914	1.072943
900.00	1.081497	1.078066	1.074829	1.071771	1.068881	1.066149	1.063566	1.061124	1.058745
900.00	1.87592%	1.79065%	1.71090%	1.63601%	1.56544%	1.49866%	1.43521%	1.37465%	1.32324%
1000.00	1.115118	1.109907	1.105027	1.100446	1.096140	1.092086	1.088265	1.084659	1.081254
1000.00	1.091109	1.087159	1.083441	1.079939	1.076638	1.073524	1.070588	1.067819	1.065137
1000.00	2.15301%	2.04960%	1.95339%	1.86349%	1.77913%	1.69961%	1.62430%	1.55261%	1.49065%

Gravity : 0.67000
N2 : 2.00000
CO2 : 0.20000
C1 : NOT_USED

Appendix 2 – Tables for NX19 Comparisons

NX19 TABLE - Gravity Method

PRESSURE PSIA	TEMPERATURE DEG F								
	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
100.00	1.005854	1.005658	1.005469	1.005285	1.005109	1.004939	1.004776	1.004618	1.004466
100.00	1.007225	1.006989	1.006762	1.006543	1.006332	1.006128	1.005932	1.005743	1.005558
100.00	0.13634%	0.13240%	0.12858%	0.12511%	0.12166%	0.11832%	0.11510%	0.11201%	0.10877%
200.00	1.012827	1.012388	1.011967	1.011554	1.011160	1.010781	1.010417	1.010066	1.009728
200.00	1.015908	1.015373	1.014859	1.014364	1.013888	1.013431	1.012992	1.012569	1.012153
200.00	0.30423%	0.29484%	0.28574%	0.27783%	0.26987%	0.26220%	0.25485%	0.24782%	0.24016%
300.00	1.019897	1.019199	1.018532	1.017874	1.017249	1.016650	1.016074	1.015520	1.014986
300.00	1.024805	1.023944	1.023118	1.022326	1.021566	1.020837	1.020138	1.019467	1.018803
300.00	0.48130%	0.46553%	0.45030%	0.43739%	0.42436%	0.41187%	0.39997%	0.38868%	0.37605%
400.00	1.027048	1.026077	1.025149	1.024233	1.023365	1.022533	1.021735	1.020968	1.020231
400.00	1.033904	1.032688	1.031525	1.030413	1.029348	1.028328	1.027353	1.026419	1.025494
400.00	0.66751%	0.64435%	0.62204%	0.60337%	0.58460%	0.56671%	0.54978%	0.53383%	0.51581%
500.00	1.034265	1.033003	1.031801	1.030614	1.029492	1.028418	1.027388	1.026400	1.025451
500.00	1.043186	1.041587	1.040060	1.038603	1.037212	1.035884	1.034616	1.033404	1.032205
500.00	0.86261%	0.83093%	0.80052%	0.77517%	0.74988%	0.72595%	0.70346%	0.68243%	0.65868%
600.00	1.041524	1.039957	1.038467	1.037000	1.035613	1.034287	1.033017	1.031799	1.030631
600.00	1.052627	1.050613	1.048696	1.046871	1.045134	1.043478	1.041901	1.040399	1.038915
600.00	1.06600%	1.02463%	0.98504%	0.95196%	0.91932%	0.88865%	0.86003%	0.83347%	0.80378%
700.00	1.048801	1.046914	1.045124	1.043367	1.041707	1.040121	1.038603	1.037150	1.035757
700.00	1.062191	1.059733	1.057399	1.055184	1.053079	1.051080	1.049180	1.047374	1.045597
700.00	1.27669%	1.22442%	1.17457%	1.13261%	1.09175%	1.05363%	1.01833%	0.98581%	0.95005%
800.00	1.056065	1.053844	1.051743	1.049690	1.047749	1.045896	1.044125	1.042431	1.040809
800.00	1.071834	1.068902	1.066128	1.063500	1.061011	1.058651	1.056415	1.054295	1.052219
800.00	1.49318%	1.42883%	1.36767%	1.31568%	1.26574%	1.21951%	1.17700%	1.13812%	1.09626%
900.00	1.063279	1.060715	1.058294	1.055939	1.053713	1.051589	1.049561	1.047622	1.045767
900.00	1.081497	1.078066	1.074829	1.071771	1.068881	1.066149	1.063566	1.061124	1.058745
900.00	1.71331%	1.63583%	1.56242%	1.49931%	1.43953%	1.38460%	1.33443%	1.28888%	1.24101%
1000.00	1.070404	1.067487	1.064740	1.062083	1.059568	1.057170	1.054883	1.052698	1.050610
1000.00	1.091109	1.087159	1.083441	1.079939	1.076638	1.073524	1.070588	1.067819	1.065137
1000.00	1.93427%	1.84281%	1.75641%	1.68127%	1.61104%	1.54696%	1.48882%	1.43641%	1.38273%

Gravity : 0.74000
N2 : 14.90000
CO2 : 14.90000
C1 : NOT_USED

Appendix 2 – Tables for NX19 Comparisons

NX19 TABLE - Methane/Gravity Method

PRESSURE PSIA	TEMPERATURE DEG F								
	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
100.00	1.009315	1.009026	1.008747	1.008477	1.008215	1.007963	1.007718	1.007482	1.007254
100.00	1.007225	1.006989	1.006762	1.006543	1.006332	1.006128	1.005932	1.005743	1.005558
100.00	0.20710%	0.20189%	0.19678%	0.19175%	0.18682%	0.18198%	0.17724%	0.17261%	0.16835%
200.00	1.020706	1.020035	1.019388	1.018765	1.018164	1.017584	1.017026	1.016487	1.015969
200.00	1.015908	1.015373	1.014859	1.014364	1.013888	1.013431	1.012992	1.012569	1.012153
200.00	0.47006%	0.45703%	0.44433%	0.43195%	0.41988%	0.40812%	0.39665%	0.38548%	0.37558%
300.00	1.032609	1.031505	1.030444	1.029425	1.028446	1.027505	1.026600	1.025729	1.024893
300.00	1.024805	1.023944	1.023118	1.022326	1.021566	1.020837	1.020138	1.019467	1.018803
300.00	0.75568%	0.73297%	0.71097%	0.68966%	0.66898%	0.64893%	0.62947%	0.61058%	0.59416%
400.00	1.045041	1.043447	1.041921	1.040460	1.039059	1.037717	1.036430	1.035196	1.034012
400.00	1.033904	1.032688	1.031525	1.030413	1.029348	1.028328	1.027353	1.026419	1.025494
400.00	1.06569%	1.03106%	0.99774%	0.96564%	0.93468%	0.90478%	0.87588%	0.84792%	0.82387%
500.00	1.058015	1.055866	1.053817	1.051861	1.049993	1.048208	1.046501	1.044869	1.043308
500.00	1.043186	1.041587	1.040060	1.038603	1.037212	1.035884	1.034616	1.033404	1.032205
500.00	1.40153%	1.35237%	1.30538%	1.26037%	1.21719%	1.17570%	1.13576%	1.09727%	1.06419%
600.00	1.071530	1.068754	1.066118	1.063611	1.061225	1.058953	1.056787	1.054722	1.052752
600.00	1.052627	1.050613	1.048696	1.046871	1.045134	1.043478	1.041901	1.040399	1.038915
600.00	1.76410%	1.69742%	1.63409%	1.57380%	1.51628%	1.46128%	1.40858%	1.35798%	1.31432%
700.00	1.085567	1.082087	1.078795	1.075677	1.072721	1.069916	1.067251	1.064717	1.062307
700.00	1.062191	1.059733	1.057399	1.055184	1.053079	1.051080	1.049180	1.047374	1.045597
700.00	2.15338%	2.06585%	1.98327%	1.90514%	1.83101%	1.76050%	1.69323%	1.62888%	1.57295%
800.00	1.100083	1.095816	1.091798	1.088008	1.084429	1.081045	1.077841	1.074804	1.071924
800.00	1.071834	1.068902	1.066128	1.063500	1.061011	1.058651	1.056415	1.054295	1.052219
800.00	2.56791%	2.45604%	2.35118%	2.25258%	2.15955%	2.07149%	1.98786%	1.90816%	1.83828%
900.00	1.114993	1.109859	1.105047	1.100527	1.096276	1.092270	1.088490	1.084919	1.081542
900.00	1.081497	1.078066	1.074829	1.071771	1.068881	1.066149	1.063566	1.061124	1.058745
900.00	3.00416%	2.86456%	2.73454%	2.61297%	2.49888%	2.39140%	2.28976%	2.19324%	2.10781%
1000.00	1.130165	1.124093	1.118426	1.113127	1.108160	1.103497	1.099112	1.094982	1.091087
1000.00	1.091109	1.087159	1.083441	1.079939	1.076638	1.073524	1.070588	1.067819	1.065137
1000.00	3.45580%	3.28567%	3.12808%	2.98149%	2.84458%	2.71616%	2.59518%	2.48066%	2.37835%

Gravity : 0.78000
N2 : 2.00000
CO2 : 5.00000
C1 : 93.00000