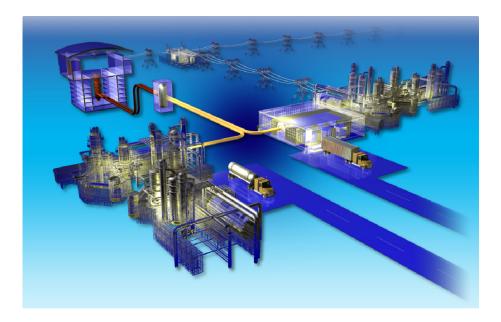
Document ID: TEV-693 Revision ID: 1 Effective Date: 05/15/10

# **Technical Evaluation Study**

Project No. 23843

# Nuclear-Integrated Hydrogen Production Analysis



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Note: Applicable QLD: REC-000101

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# **REVISION LOG**

Rev.	Date	Affected Pages	Revision Description
0	11/03/09	All	Newly issued document.
1	05/15/10	All	Added economic sections and URS & INL comments

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# **EXECUTIVE SUMMARY**

This technical evaluation (TEV) has been prepared as part of a study for the Next Generation Nuclear Plant (NGNP) Project to evaluate integration of high temperature gas-cooled reactor (HTGR) technology with conventional chemical processes. This TEV addresses the integration of an HTGR with high-temperature steam electrolysis (HTSE). The main products are hydrogen and oxygen.

An HTGR can produce steam, high-temperature helium, and/or electricity. In conventional processes, these products are generated by the combustion of fossil fuels such as coal and natural gas, resulting in significant emissions of greenhouse gases such as carbon dioxide. Heat or electricity produced in an HTGR could be used to supply process heat or electricity to conventional processes without generating any greenhouse gases. This report describes how nuclear-generated heat and electricity could be integrated into the HTSE process, provides a preliminary economic analysis of the process, and assesses greenhouse gas (GHG) emissions of the conventional steam methane reforming (SMR) process and nuclear-integrated HTSE.

The following list identifies the major conclusions drawn by evaluating the nuclearintegrated HTSE process against the conventional process, SMR:

- Four and one third 600-MW<sub>t</sub> HTGRs are required to support the production of 719 tons/day of hydrogen and 5,668 tons/day of oxygen using HTSE. An SMR process requires 2078 tons of natural gas to produce the same amount of hydrogen. The SMR process emits 3,393 tons/day of carbon dioxide (CO2). The nuclear-integrated HTSE process emits 0 tons/day.
- At a 12% internal rate of return (IRR), the price of hydrogen from an HTGR with a 750°C outlet temperature using HTSE is \$3.67/kg. Estimated SMR prices vary from \$1.26/kg to \$2.51/kg.

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# NUCLEAR-INTEGRATED HYDROGEN PRODUCTION ANALYSIS

# **1. INTRODUCTION**

This technical evaluation (TEV) has been prepared as part of a study for the Next Generation Nuclear Plant (NGNP) Project to evaluate integration of high-temperature gas-cooled reactor (HTGR) technology with conventional chemical processes. The NGNP Project is being conducted under U.S. Department of Energy (DOE) direction to meet a national strategic need identified in the *National Energy Policy* to promote reliance on safe, clean, economic nuclear energy and to establish a greenhouse-gas-free technology for the production of hydrogen. The NGNP represents an integration of high-temperature reactor technology with advanced hydrogen, electricity, and process heat production capabilities, thereby meeting the mission need identified by DOE. The strategic goal of the NGNP Project is to broaden the environmental and economic benefits of nuclear energy in the U.S. economy by demonstrating its applicability to market sectors not being served by light water reactors.

An HTGR produces steam, high-temperature helium, or electricity. A summary of these products and a brief description is shown in Table 1. In conventional processes, these products are generated by the combustion of fossil fuels such as coal and natural gas, resulting in significant emissions of greenhouse gases such as carbon dioxide. Heat or electricity produced in an HTGR could be used to supply process heat or electricity to conventional processes without generating any greenhouse gases. The use of an HTGR to supply process heat or electricity to conventional processes is referred to as a nuclear-integrated process. This report describes how nuclear-generated heat or electricity could be integrated into conventional processes and provides a preliminary economic analysis to show which nuclear-integrated processes compare favorably with conventional processes.

HTGR Product	Product Description				
Steam	540 to 593°C and 17 to 24 MPa				
High-Temperature Helium	Up to 750°C and 9.1 MPa				
Electricity	Generated by Rankine cycle with thermal efficiency of 40%				

Table 1. Project outputs of an HTGR.

In 2009, an independent review team considered three hydrogen production technologies to be combined with a next generation nuclear plant.<sup>1</sup> Those technologies included the sulfur iodine (SI) process, the hybrid sulfur (HyS) process and the HTSE process. The review team recommended the HTSE process as the first choice for the NGNP Project, with HyS as the second option. The purpose of this TEV is to present the process modeling and economic results from producing hydrogen from high-temperature steam electrolysis combined with a high-temperature gas reactor. These results are used in other process models developed under the NGNP program where HTGR-integrated hydrogen may be integrated with industrial processes. The economics of this TEV are used to estimate the overall economics of these combined nuclear and industrial processes.

The Advanced Process and Decision Systems Department at Idaho National Laboratory (INL) has spent several years developing detailed process simulations of chemical and thermodynamic processes. The processes included HTSE combined with a variety of nuclear reactors. These simulations have been developed using HYSYS Process and ASPEN PLUS—state-of-the-art, steady-state, thermodynamic, and chemical process simulators developed by Hyprotech and

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ASPEN. This study makes extensive use of these models and the modeling capability at INL to evaluate the integration of HTGR technology with potential hydrogen production technologies.

This TEV assumes familiarity with HYSYS Process and APSEN PLUS software, so a detailed explanation of the software capabilities, thermodynamic packages, unit operation models, and solver routines is beyond the scope of this TEV. Also assumed is a familiarity with thermodynamic, heat exchange, and heat recuperation systems; hence, a thorough explanation of these technologies is also considered to be beyond the scope of this TEV.

## 2. MODELING OVERVIEW

#### 2.1 Introduction

The purpose of this modeling effort is to predict the flow of hydrogen output of HTSE combined with a 600 MWt reactor. The hydrogen and oxygen flows are used with other process models where the hydrogen may be used in substitute of hydrogen from other processes. The model also includes the resources needed to accomplish the production rates including electrical power and water usage. By combining this model with other process models being developed in the NGNP program, an overall picture of nuclear integrated chemical processing may be achieved. The scale of the modeling within Section 2 is based on a steam methane reforming (SMR) process that produces 719 tons/day of hydrogen.

#### 2.2 Hydrogen Production via Steam Reforming of Methane

Hydrogen is a key element for making fuels and other industrial chemicals. Industry is currently making hydrogen from natural gas via steam reforming. Water and methane are feeds for the process in which some of the methane is used to make steam and the remainder is combined with the steam to create hydrogen and carbon dioxide. The two basic chemical equations describing the process, methane reforming and gas shift, are:

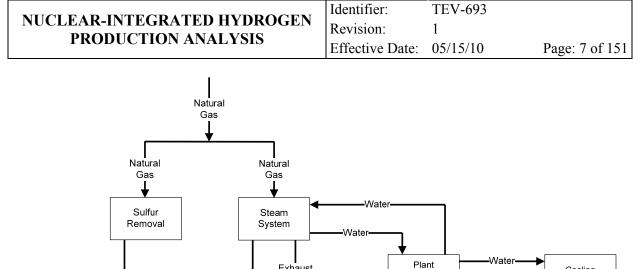
$$CH_4 + H_2O \Leftrightarrow CO + 3H_2$$

$$CO + H_2O \Leftrightarrow CO_2 + H_2.$$
(1)
(2)

Figure 1 is a simplified block diagram showing the major process components. The process was modeled using ASPEN PLUS process modeling software. Four processes were modeled: methane reforming, gas shift, cleanup, and cooling.

Cooling

Towers



Exhaust

H<sub>2</sub>-Rich Syngas

Water

Treatment

Nate

Shift & Syngas

Conditioning

 $\dot{CO_2}$ 

Wate

Figure 1. Hydrogen production through the steam reforming of natural gas.

#### 2.3 **Hydrogen Production via HTSE**

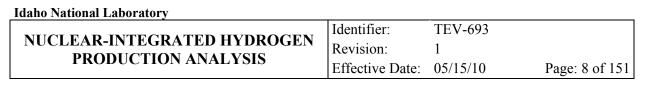
Stean

Natural Gas

Reformer

Exhaust

Hydrogen can also be produced using a high-temperature nuclear reactor by way of HTSE. The heat and electrical power from the reactor can be used to split water using solid oxide electrolysis cells, (SOEC) to create hydrogen and oxygen. The process heat from the reactor reduces the amount of electricity needed to split the water, thus increasing the efficiency of the process when compared to low-temperature electrolysis. Figure 2 is a simplified diagram of the process. The HYSYS process modeling software was used to model the HTSE process. The process model included heat recuperation and the power from a nuclear high-temperature gas reactor. HYSYS allows for accurate mass and energy balances and contains components like compressors, turbines, pumps, valves, and heat exchangers to simulate components in the process. Figure 3 diagrams the HTSE process in detail.



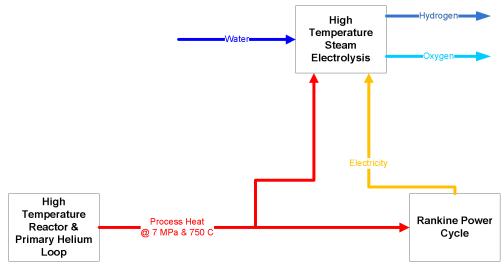


Figure 2. Hydrogen production via HTSE.

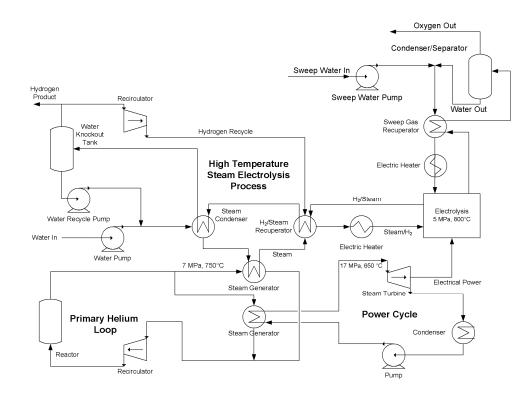


Figure 3. Process flow diagram of HTSE process.

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#### RESULTS OF PROCESS MODEL

The block flow diagram of the hydrogen processes shown in Figure 4 includes the input and product streams for each process. The size of each process was adjusted to the hydrogen production expected from a typical steam reformer, equaling 700 tons/day of hydrogen. To achieve this, the steam reformer requires 2,000 tons/day of natural gas resulting in nearly 3,400 tons/day of carbon dioxide emissions. Nearly 12 MWe of electricity is needed to support the process along with 1,360 gal/minute of water to supply steam and cooling.

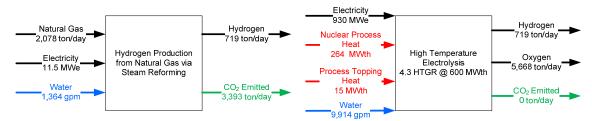


Figure 4. Block flow diagram of hydrogen production technologies.

The HTSE process produces no carbon dioxide but has a 930 MWe electrical load. The electrical power is primarily for the actual electrolysis process as shown in Table 2. The process requires 264 MWt of process heat from the reactor to create the steam necessary for the electrolysis process. The recuperating heat exchangers have a total duty of 230 MWt. It is assumed in this analysis that the steam generator can deliver 700°C steam to the electrolysis cells. The HTSE process requires the feed stream to be heated to 800°C, requiring additional topping heat from another heat source. This heat source could come from a combustor, electricheating or waste heat from a neighboring process, which may need to use the hydrogen from the HTSE process. The topping heat is 15 MWt. This analysis assumes that the topping heat either comes from electric heating or from other processes. If the heat is supplied by a neighboring process, the carbon footprint should already be accounted for by that process, making the carbon footprint of the hydrogen process at zero. This process requires much more water than the steam reforming process. The primary need for the water is for cooling of the reactors, as seen in Table 2. The electrical and process heat needs require 4.3 high-temperature gas reactors rated at 600 MWt. The hydrogen product has a purity of 99.9% with water as the remaining component. Oxygen is a byproduct of the HTSE process that may also be used in other chemical processes. The purity of the oxygen stream is 99.99% with water as the remaining component.

The hydrogen production efficiency was calculated for both processes. The hydrogen production efficiency is defined as the thermal value of the hydrogen product divided by the sum of thermal value of the feed streams, process heat in, and thermal equivalent of the electric power. The efficiency is basically the thermal value of the hydrogen output divided by the thermal value of the input. For the steam reforming case, the hydrogen production efficiency is the higher heating value of the hydrogen divided by the sum of the higher heating value of the natural gas and the thermal energy equivalent of the electrical power input. The thermal value of the electricity is found by the electrical power divided by the efficiency of the power cycle. The power cycle efficiency in this study was assumed at 40%. The hydrogen production efficiency for the HTSE process is the higher heating value of the hydrogen product divided by the sum of the thermal energy of the electrical power produced, the process heat from the reactor, and the topping heat. The hydrogen production efficiency of primarily by the

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natural gas input, whereas the electrical power has the greatest influence for the HTSE case (see Table 2). The HTSE case has an efficiency of 40.4%, very close the power cycle efficiency for the electrical power, whereas the steam reforming case has an efficiency of 79.4%.

	Steam Methane Reforming	High Temperature Steam Electrolysis
Inputs		
Natural Gas Rate (ton/day)	2,078	0
# 600 MWt HTGRs Required	n/a	4.3
Intermediate Products		
Syngas (ton/day)	8,768	n/a
Syngas Produced /Natural Gas Fed (lb/lb)	4.2	n/a
Outputs		
Hydrogen (ton/day)	719	719
Hydrogen Production Efficiency	79.4%	40.4%
(Power Cycle Efficiency = 40%)		
Oxygen (ton/day)	0	5,668
Utility Summary		
Total Power (MWe)	11.5	930
Electrolyzers	n/a	923
NG Reformer	3.5	n/a
Gas Cleaning	3.6	n/a
Water Treatment	2.8	0
Cooling Towers	0.6	6.9
Power Block	1.0	n/a
Pumps	n/a	0.5
Recirculator	n/a	0.1
Process Heat		
Total Process Heat (MWt)	n/a	278
Process Heat from Reactor (MWt)	n/a	264
Topping Process Heat (MWt)	n/a	14.9
Water Consumption		
Total Water (gpm)	1,364	9,914
Water Consumed/Hydrogen Produced		
(lbm/lbm)	11.5	83.3
CO2 Emissions		
Emitted (ton/day CO <sub>2</sub> )	3,393	0

Table 2. Hydrogen production summary.

# **3. ECONOMIC MODELING**

The economic viability of the HTSE process was assessed using standard economic evaluation methods. The economics were evaluated for the HTSE process combined with a single 600 MWt HTGR with a Rankine steam power cycle. Future work will include an economic analysis of the SMR process. The total capital investment (TCI), based on the total equipment costs, along with the variable and fixed operating costs were first calculated for the cases. The present worth of the annual cash flows (after taxes) was then calculated for the TCI, as well as the TCI at +50% and -30% of the HTGR cost, with the debt-to-equity ratios equal to 80%/20%. The following sections

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describe the methods used to calculate the capital costs, fixed and variable operating costs, and the methods used for the economic assessments. All calculations assume that a 600 MWt HTGR is used to produce only hydrogen and oxygen via HTSE by supplying electricity and process heat. The economic analysis includes the HTSE process, the power cycle, and the reactor.

For the nuclear-integrated cases, the estimates of capital costs and operating and maintenance costs assumed the nuclear plant was an "n<sup>th</sup> of a kind", (NOAK). In other words, the estimates were based on the costs expected after the HTGR technology is integrated into an industrial application more than 10 times. The economic modeling calculations were based on two capital cost scenarios: a current best estimate of \$2,000/kWt ["INL/BEA Pre-Conceptual Design Report name"] and a target of \$1,400/kW<sub>th</sub> [personal communications with Larry Demick] where kW<sub>th</sub> is the thermal rating of the plant. In comparison, light water nuclear reactor costs are approximately  $$1,250/kW_{th}$ . Based on the two capital cost scenarios for HTGR technology, the nominal capital cost for a 600 MW<sub>th</sub> HTGR would be \$1.2 billion; the target capital cost would be \$840 million.

#### 3.1 Capital Cost Estimation

The capital installed costs for the HTSE process are based on a report by Harvego et al.<sup>2</sup> which assumes hydrogen production from a 600 MWt high-temperature gas reactor with an outlet temperature of 900°C. At that temperature, the power cycle efficiency is 53% with a corresponding hydrogen production rate of 2.4 kg/sec. For the current NGNP case, the power cycle efficiency is 40% with a hydrogen production flow rate of 1.75 kg/sec. The hydrogen production system in the Harvego report used air as the sweep gas, whereas this analysis used steam for the sweep gas. The change in type of sweep gas was selected to be able to provide an oxygen product. Water as a sweep gas is more easily separated from oxygen generated than the nitrogen from the air in the air sweep option. Heat exchanger costs in the HTSE process were adjusted in this analysis to account for the different sizes. Air sweep compressor costs (including intercoolers) were removed and a water pump for the sweep gas was added. The water for the sweep side is heated to make steam which sweeps the oxygen from the electrolyzers. The water is removed from the oxygen by condensing and recycled. To size the sweep pump, the flow rate of the pump was adjusted until the outlet molar composition of the electrolysis unit was 50% oxygen and 50% steam. The same installed cost factors found in the Harvego report were used to adjust the cost of the equipment. The costs from the Harvego report are 2005 costs; Table 3 shows the adjusted capital costs. This analysis is performed using 2009 costs; therefore the Chemical Engineering Plant Cost Index (CEPCI) was used to adjust the costs to 2009 dollars. Uninstalled costs are the basic cost of the equipment from the manufacturer. Installed costs are the uninstalled costs plus the additional materials and labor needed to place and install the equipment.

Harvego et al. used *A Guide to Chemical Engineering Process Design and Economics*<sup>3</sup> to estimate the costs of the separation tanks, steam generators, and heat recuperators. This analysis uses the separation tank cost found in Harvego et al., but linearly interpolates the cost of the steam generators and recuperators based on the overall heat transfer coefficient and heat transfer area product (UA) of the heat exchangers, because the heat exchanger sizes differ between cases. The topping heaters do not have a UA in the process model, but a similar approach was used in scaling the cost using the heat duty instead of the UA.

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The pumps and hydrogen circulator come directly from the Harvego report and differ only in quantity. Harvego et al. used the Matches' Process Equipment Cost Estimates Website<sup>4</sup> to obtain the capital costs for these components. The *H2-MHR Pre-Conceptual Design Report: HTE-Based Plant*<sup>5</sup> was used by Harvego et al. to cost the water supply system, piping, electrical capital, and miscellaneous equipment.

In the Harvego report, the cost of the electrolysis cells is \$200/kWe, based on the power into the cells. This was derived from a 2007 goal of the Solid State Energy Conversion Alliance (SECA) for solid oxide fuel cells. The goal was set to \$400/kWe for the fuel cells, but because solid oxide electrolysis cells run at twice the voltage for the same current density, the electrolysis cells are half the cost. At a recent SECA conference, the goal for solid oxide fuel cells has changed to \$175/kWe, which when halved for SOEC comes to \$87.5/kWe.<sup>6</sup> Consulting with HTSE experts, INL, and Ceramatec, a NOAK goal of \$100/kWe was used for this study.<sup>7,8</sup>

The 4.74 installed cost factor is based on the Lang factor for predominately fluid processing plants. The Lang factor is the multiplier used on the major equipment cost to account for installing a process in a plant. The 1.2 cost factor is based on Reference 5. The 1.8 cost factor is based on consultation with experts at INL and Cerametec on HTSE.<sup>7,8</sup>

A percentage breakdown of the installed capital costs of the HTSE process without reactor and power cycle costs is shown in Figure 4. The results show that 2/3 of the cost is due to the electrolysis cells. The results indicate that a sensitivity study of the cell cost could be beneficial. However when cost of the reactor and the cost of the power cycle, the capital cost of the HTSE process is only 8.41%, see Figure 5.

Equipment	2005 Uninstalled Costs	2009 Uninstalled Costs	Installed Cost Factors	2009 Installed Costs		
Water Separation Tanks	\$143,980	\$157,449	4.74	\$746,310		
Recycle Pumps	\$18,800	\$20,559	4.74	\$97,448		
Water Supply System	\$1,000,000	\$1,093,550	1.2	\$1,312,260		
Water Pumps	\$41,400	\$45,273	4.74	\$214,594		
Heat Recuperators	\$1,186,193	\$1,297,161	4.74	\$6,148,543		
Steam Generators	\$765,529	\$837,144	4.74	\$3,968,062		
Topping Heaters	\$190,000	\$207,774	4.74	\$984,851		
Hydrogen Circulator	\$19,600	\$21,433	4.74	\$101,595		
HSTE Piping	\$1,250,000	\$1,366,937	1.2	\$1,640,325		
Electrical	\$2,000,000	\$2,187,100	1.2	\$2,624,519		
Misc. Equipment	\$2,500,000	\$2,733,874	1.2	\$3,280,649		
Solid Oxide Electrolyzer	\$21,383,267	\$23,383,667	1.8	\$42,090,600		
Total Installed Cost \$63,209,757						

Table 3. Capital costs of HTSE connected to a 600 MWt HT
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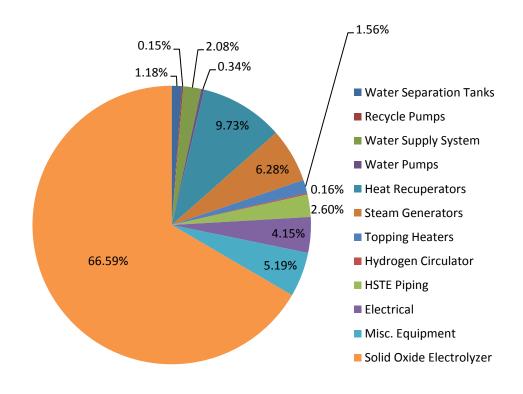


Figure 4. Installed capital costs of HTSE without reactor and power cycle costs.

The capital costs presented are for inside the battery limits, and exclude costs for administrative offices, storage areas, utilities, and other essential and nonessential auxiliary facilities. The estimate presented is a study (factored) estimate which has a probable error up to  $\pm 30\%$ .<sup>9</sup> Fixed capital costs were estimated from literature estimates and scaled estimates (capacity, year, and material) from previous quotes. Capacity adjustments were based on the six-tenths factor rule:

$$C_2 = C_1 \left(\frac{q_2}{q_1}\right)^n \tag{3}$$

where  $C_1$  is the cost of the equipment item at capacity  $q_1$ ,  $C_2$  is the cost of the equipment at capacity  $q_2$ , and n is the exponential factor, which typically has a value of 0.6.<sup>10</sup> It was assumed that the number of trains did not have an impact on cost scaling. Cost indices were used to adjust equipment prices from previous years to values in July of 2009 using the CEPCI.

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Table 4. CEPCI data.					
Year	CEPCI	Year	CEPCI		
1990	357.6	2000	394.1		
1991	361.3	2001	394.3		
1992	358.2	2002	395.6		
1993	359.2	2003	402		
1994	368.1	2004	444.2		
1995	381.1	2005	468.2		
1996	381.7	2006	499.6		
1997	386.5	2007	525.4		
1998	389.5	2008	575.4		
1999	390.6	July 2009	512		

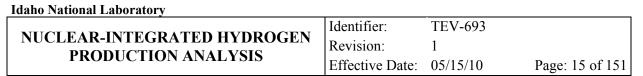
After cost estimates were obtained for each of the process areas, the costs for water systems, piping, instrumentation and control, electrical systems, and buildings and structures were added based on scaling factors for the total installed equipment costs.<sup>11</sup> These factors were not added to the cost of the HTGR or the power cycle. Table presents the factors utilized in this study:

Table 5. Capital cost adjustment factors.

Year	Factor
Water Systems	7.1%
Piping	7.1%
Instrumentation and Control	2.6%
Electrical Systems	8.0%
Buildings and Structures	9.2%

Finally, an engineering fee of 10% and a project contingency of 18% were assumed to determine the total capital investment (TCI). Neither engineering fees nor contingencies were applied to the HTGR costs. Table presents the capital cost estimate breakdown for the HTSE. These cost factors are applied only to the installed costs of the HTSE equipment; therefore, the numbers in Table 6 show those costs only as applied to HTSE alone. The water systems, piping, instrumentation and control, electrical systems, and buildings and structures costs are already incorporated in the reactor and power cycle costs and are represented by the numbers shown. Figure 5 shows the total capital investment cost for all three major components for nuclear-integrated hydrogen production. The HTSE TCI is only 8.41% of the total TCI.

Cost estimators at the INL performed a capital cost analyses for a number of nuclear integrated industrial processes. The HTSE and power cycle capital costs are a part of many of these analyses. In appendix D is the capital cost analyses for ammonia production. Based on this analysis and scaled to a 600 MWt reactor, the total capital costs of the reactor, power cycle and HTSE are \$1,025,100,000; \$170,600,000; and \$109,900,000. The total capital cost is \$1,305,600,000.



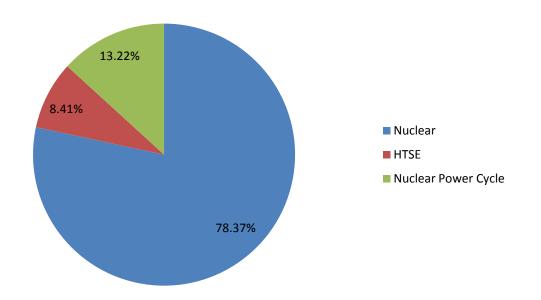


Figure 5. Total capital investment cost for HTSE hydrogen production connected to a 600 MWt HTGR.

Table 6. Total capital investment, HTSE connected to a 600 MWt HTGR.

	Installed Cost	Engineering Fee	Contingency	Total Capital Cost
Nuclear				\$1,025,000,000
Power Cycle	\$133,258,047	\$13,325,805	\$26,385,093	\$172,968,945
HTSE Total	\$ 84,706,502	\$ 8,470,650	\$ 16,771,887	\$ 109,949,039
HTSE Major Equipment	\$63,209,150	\$6,320,915	\$12,515,412	\$82,045,477
Cooling Towers	\$4,657	\$466	\$922	\$6,045
Water Systems	\$4,488,180	\$448,818	\$888,660	\$5,825,658
Piping	\$4,488,180	\$448,818	\$888,660	\$5,825,658
I&C	\$1,643,559	\$164,356	\$325,425	\$2,133,340
Electrical Systems	\$5,057,105	\$505,710	\$1,001,307	\$6,564,122
Buildings and Structures	\$5,815,670	\$581,567	\$1,151,503	\$7,548,740
Total Capital Investment		·		\$1,307,917,985
Total Capital Investment (+50	)% HTGR)			\$1,820,417,985
Total Capital Investment (-30	% HTGR)			\$1,000,417,985

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#### **3.2** Estimation of Revenue

Yearly revenues were estimated for the HTSE case. Revenues were estimated for low, average, and high prices for hydrogen.

	Price Generated		Price		Annual Revenue
Oxygen	0.04586	\$/kg	13.8	kg/s	\$18,351,646
Hydrogen - Low	1.50	\$/kg	1.75	kg/s	\$76,158,819
Hydrogen – Avg.	3.25	\$/kg	1.75 kg/s		\$165,010,774
Hydrogen - High	5.00	\$/kg	1.75	kg/s	\$253,862,730
Annual Revenue, low				\$94,510,465	
Annual Revenue, average			\$183,362,420		
Annual Revenue, high				\$272,214,375	

Table 7. Annual revenues, HTSE connected to a 600 MWt HTGR.

#### **3.3 Estimation of Manufacturing Costs**

Manufacturing cost is the sum of direct and indirect manufacturing costs. Direct manufacturing costs for this project include the cost of raw materials, utilities, and operating labor and maintenance. Indirect manufacturing costs include estimates for the cost of overhead and insurance and taxes.<sup>9</sup>

Table 8 shows the items that need to be considered for operation and maintenance. The expected duration of the electrolysis cells for NOAK is 8 years. Assuming that one-eighth of the cells are replaced every year, and based on the \$100/kWe cost of the cells, the yearly replacement cost is \$2,714,310. The number of staff members is an estimate based on the Harvego document. The water usage for the electrolyzer and the sweep gas comes from the HTSE process model. The cooling tower water usage is calculated from the ambient heat load from the model and from using the estimation procedure found in Keeper.<sup>12</sup> The electrical power usage and product flow rates are found in the process model. Finally, it was necessary to estimate the water needed to start the system by considering the sweep gas and the electrolysis recycle loops. The volumes of each major component were estimated by allowing a 10-minute resident time of the flow in each vessel.

Labor costs are assumed to be 1.15% of the total capital investment. Maintenance costs were assumed to be 3% of the total capital investment.<sup>13</sup> The power cycles and HTSE were not included in the TCI for operation and maintenance costs, as they were calculated separately. Taxes and insurance were assumed to be 1.5% of the total capital investment, excluding the HTGR, an overhead of 65% of the labor and maintenance costs was assumed, and royalties were assumed to be 1% of the coal or natural gas cost.<sup>13</sup> Table 9 provides the manufacturing costs for the HTSE case. Availability of the nuclear plant was assumed to be 92%.

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Table 8. Operations and maintenance cost considerations for HTSE.				
Water usage (gpm) 436.9				
Initial water need (gallons)	19,400			
Electrical power (kWe)	214,000			
Oxygen product (m <sup>3</sup> /s)	10.2			
Hydrogen product (m <sup>3</sup> /s)	20.4			

#### Table 9. Annual manufacturing costs, HTSE connected to a 600 MWt HTGR.

		Price	Cons	sumed	Annual Cost
Direct Costs					
Materials					
Water Clarification	0.024	\$/1000 gal	629,136	gal/day	\$5,167
Water Treatment	1.315	\$/1000 gal	356,976	gal/day	\$157,621
HTSE Cell Replacements	0.024	\$/lb H <sub>2</sub>	333,333	lb/day H <sub>2</sub>	\$2,714,310
Nuclear Fuel	4.22	\$/MWt-h	600	MWt	\$20,416,590
Utilities					
Water	0.046	\$/k-gal	629,136	gal/day	\$9,718
Labor and Maintenance					\$3,110,680
O&M Nuclear					\$8,276,996
Indirect Costs					
Overhead					\$2,021,942
Insurance and Taxes					\$4,243,770
Manufacturing Costs					\$40,956,793

#### **3.4** Economic Comparison

To assess the economics of the HTSE case, several economic indicators were calculated. The IRR for low, average, and high hydrogen selling prices was calculated. In addition, the fuel price necessary for a return of 12% was calculated. The following assumptions were made for the economic analyses:

- The plant startup year is 2014
- A construction period of five years for the nuclear plant that begins in 2009
  - It is assumed that all reactors come online at the same time
  - Percent capital invested for the HTGR is 20% per year
- Plant startup time is one year
  - Operating costs are 85% of the total value during startup
  - Revenues are 60% of the total value during startup

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- The analysis period for the economic evaluation assumes an economic life of 30 years, excluding construction time (the model is built to accommodate up to 40 years)
- An inflation rate of 2.5% is assumed
- Debt-to-equity ratios of 80%/20% and 55%/45% are calculated; however, results are only presented for 80%/20% as this would be most consistent for an NOAK plant
  - The interest rate on debt is assumed to be 8%
  - The repayment term on the loan is assumed to be 15 years
- The effective income tax rate is 38.9%
  - State tax is 6%
  - Federal tax is 35%
- Modified Accelerated Cost-Recovery System (MACRS) depreciation is assumed.

## 3.4.1 Cash Flow

To assess the IRR and present worth (PW) of each scenario, it is necessary to calculate the after tax cash flow. To calculate the after tax cash flow (ATCF) it is necessary to first calculate the revenues ( $R_k$ ), cash outflows ( $E_k$ ), sum of all noncash, or book, costs such as depreciation ( $d_k$ ), net income before taxes (NIBT), the effective income tax rate (t), and the income taxes ( $T_k$ ), for each year (k). The taxable income is revenue minus the sum of all cash outflow and noncash costs. Therefore the income taxes per year are defined as follows:

$$T_k = t \left( R_k - E_k - d_k \right) \tag{4}$$

Depreciation for the economic calculations was calculated using a standard MACRS depreciation method with a property class of 15 years. Depreciation was assumed for the total capital investment over the five year construction schedule, including inflation.

Table presents the recovery rates for a 15 year property class:

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Table 10. MACRS depreciation.

Year	Recovery Rate	Year	Recovery Rate
1	0.05	9	0.0591
2	0.095	10	0.059
3	0.0855	11	0.0591
4	0.077	12	0.059
5	0.0693	13	0.0591
6	0.0623	14	0.059
7	0.059	15	0.0591
8	0.059	16	0.0295

The ATCF is then the sum of the before tax cash flow (BTCF) minus the income taxes owed. Note that the expenditures for capital are not taxed but are included in the BTCF each year there is a capital expenditure ( $C_k$ ); this includes the equity capital and the debt principle. The BTCF is defined as follows:

$$BTCF_k = R_k - E_k - C_k \tag{5}$$

The ATCF can then be defined as:

$$ATCF_k = BTCF_k - T_k \tag{6}$$

#### 3.4.2 Internal Rate of Return

The IRR method is the most widely used rate of return method for performing engineering economic analyses. This method solves for the interest rate that equates the equivalent worth of an alternative's cash inflows to the equivalent worth of cash outflows (after tax cash flow), i.e., the interest rate at which the PW is zero. The resulting interest is the IRR (i'). For the project to be economically viable, the calculated IRR must be greater than the desired minimum annual rate of return (MARR).

$$PW(i^{\prime}\%) = \sum_{k=0}^{N} ATCF_{k} (1+i^{\prime})^{-k} = 0$$
(7)

IRR calculations were performed for an 80%/20% debt-to-equity ratio (results for the 55%/45% ratio can be found in Appendix C for HTSE) for +50% TCI and -30% TCI for the HTGR at low, average, and high prices. In addition, the price of hydrogen necessary for an IRR of 12% and a PW of zero was calculated for each case at each debt-to-equity ratio. The IRR and hydrogen

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price required (for an IRR of 12%) was solved for using the Goal Seek function in Excel.

# 4. ECONOMIC MODELING RESULTS

Table 11 presents the results for an 80%/20% debt-to-equity ratio for HTSE. Figure depicts the associated IRR results for HTSE.

Table 11. HTSE connected to a 600 MWt HTGR IRR results for 80%/20% debt-to-equi	y ratio.
---	----------

	TCI -30	% HTGR	TCI		TCI +50% HTGR	
	IRR	\$/kg	IRR	\$/kg	IRR	\$/kg
	\$1,000,	417,985	\$1,307,	917,985	\$1,820,	417,985
	3.31	\$1.50	1.22	\$1.50	-1.08	\$1.50
HTSE	13.79	\$3.25	10.28	\$3.25	6.70	\$3.25
	21.65	\$5.00	16.88	\$5.00	12.10	\$5.00
	12.00	\$2.90	12.00	\$3.67	12.00	\$4.96

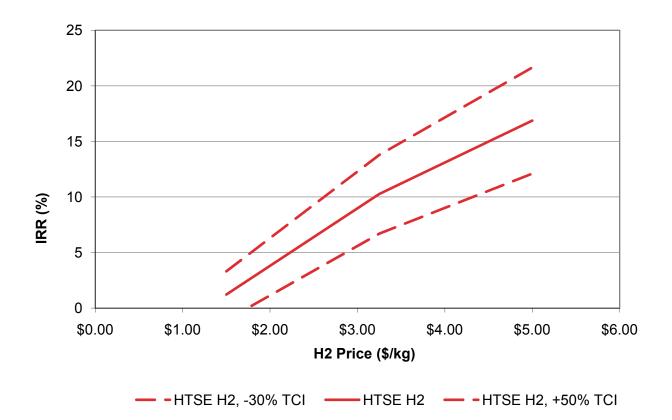


Figure 6. HTSE connected to a 600 MWt HTGR IRR 80%/20% debt-to-equity economic results.

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The cost of hydrogen for an 80% debt to 20% equity and a 12% IRR is 3.67/kg. The cost of the hydrogen ranges from 2.90/kg to 4.96 based a +50% to a -30% on the capital cost of the reactor.

It is likely that many industrial processes will require more than 1.75 kg/s of hydrogen. The price of hydrogen production would likely go down if considering economy of scale.

# 5. CONCLUSIONS AND RECOMMENDATIONS

For a 600 MWt high-temperature gas reactor with an outlet temperature of 750°C dedicated to hydrogen production using HTSE, the following conclusions may be made:

- HTSE delivers 1.75 kg/s of hydrogen and 13.8 kg/s of oxygen
- The hydrogen is produced with no production of carbon dioxide
- Based on a 12% IRR and 80/20 debt-to-equity, the cost of hydrogen is \$3.67/kg
- Total installed capital cost for HTSE is \$82 million
- Total capital investment is \$1.3 billion
- Two-thirds of the installed capital cost for the HTSE process is electrolysis cells excluding the cost of the reactor and power cycle
- 78% of the total capital investment is the reactor cost
- 2,300 gallons per minute of water is needed for the process, most of which is used for the condenser of the power cycle.

For these conclusions, one is assuming NOAK for the reactor and HTSE costs.

Based on an INL report,<sup>2</sup> a 600 MWt reactor with an outlet reactor temperature of 900°C can produce 2.36 kg/s of hydrogen. This is a 35% increase of hydrogen production. The increase is due to an increase in the power cycle efficiency from 40% to 53%, resulting in the higher production of hydrogen. At this temperature the need for topping heat goes away for the HTSE process.

Water is also a major concern due to the cooling need of the power cycle loop. By using an air-cooled tower, the reduction of water usage may be achieved.

It is recommended that:

• A similar analysis, as outlined in this TEV, is performed at a reactor outlet temperature of 900°C

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- A process model is developed using air-cooled condensers as opposed to water cooled.
- A similar analysis is performed considering economy of scale.
- A sensitivity analysis of the cell costs should be performed.

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# 7. APPENDIXES

Appendix A, Steam Methane Reforming Detailed Results

Appendix B, High-Temperature Steam Electrolysis Results

Appendix C, 55%/45% Debt-to-Equity Results

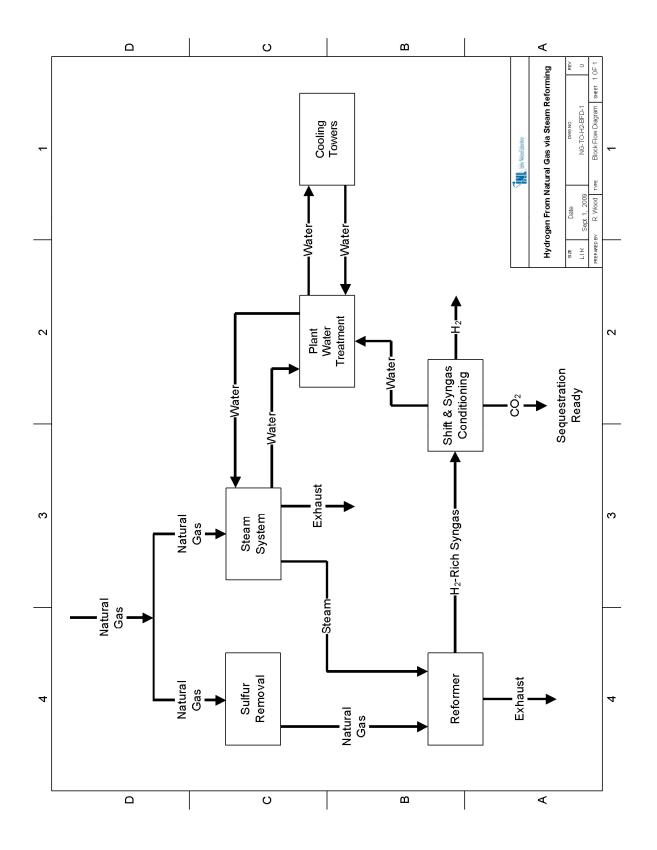
Appendix D, Cost Estimate Support Data Recapitulation

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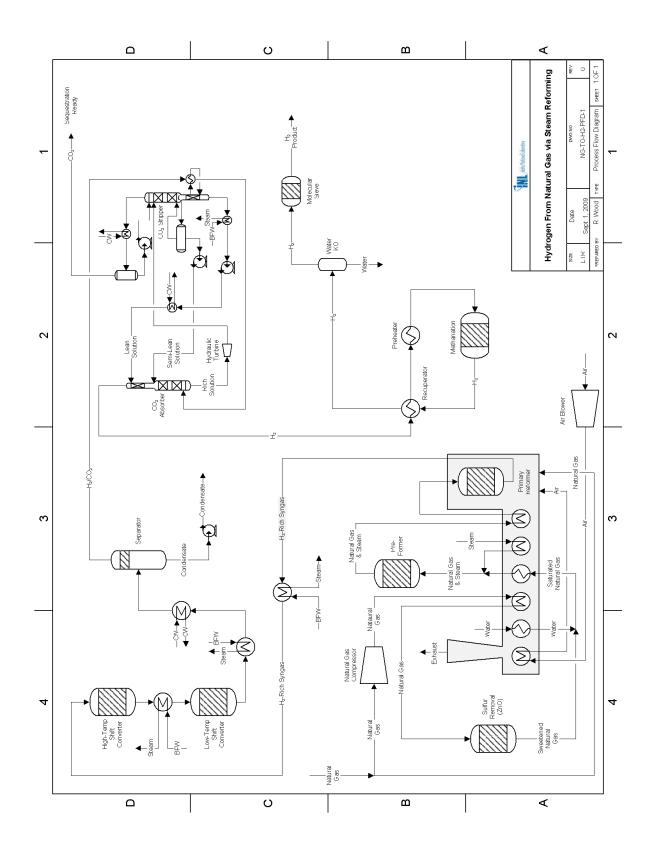
# Appendix A Steam Methane Reforming Detailed Results

The model of the steam methane reforming process and results in Appendix A were developed using Aspen Plus version 2006 (20.0.2.3781) from AspenTech on a desktop computer running Microsoft Windows XP Professional Version 2002 Service Pack 3.

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Appendix A

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H2 Production Calculator Block SUMMARY	from Natural Gas Summary
FEED SUMMARY:	
NATURAL GAS PROPERTIES:	
MASS FLOW = VOLUME FLOW = HHV = HHV = ENERGY FLOW =	2078. TON/DY 92. MMSCFD @ 60°F 23061. BTU/LB 1044. BTU/SCF @ 60°F 95820. MMBTU/DY
COMPOSITION: METHANE = ETHANE = PROPANE = BUTANE = HEXANE = HEXANE = NITROGEN = OXYGEN = CO2 = C4H10S = C2H6S = H2S =	93.568 MOL.% 3.749 MOL.% 0.920 MOL.% 0.260 MOL.% 0.040 MOL.% 0.010 MOL.% 0.100 MOL.% 0.250 MOL.% 30. PPMV 3. PPMV 5. PPMV
INTERMEDIATE PRODUCT SUMMARY: RAW SYNGAS MASS FLOW = RAW SYNGAS VOLUME FLOW = RAW SYNGAS COMPOSITION: H2 CO CO2 N2 H2O CH4 FINAL PRODUCT SUMMARY:	730631. LB/HR 490. MMSCFD @ 60°F 41.0 Mol.% 6.3 Mol.% 5.7 Mol.% 0.1 Mol.% 46.1 Mol.% 0.7 Mol.%
HYDROGEN MASS FLOW = HYDROGEN VOLUME FLOW = HYDROGEN COMPOSITION: H2 N2 CH4 C0 H2 PRODUCED / NATURAL GAS FEE CARBON DIOXIDE MASS FLOW = CARBON DIOXIDE VOLUME FLOW = CARBON DIOXIDE COMPOSITION: C02 H2 N2	282724. LB/HR
СН4 СО Н2О	0. PPMV 0. PPMV 1. PPMV

POWER SUMMARY:

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H2 Production fro	om Natural Gas Summary
ELECTRICAL CONSUMERS: NG REFORMER POWER CONSUMPTION GAS CLEANING POWER CONSUMPTION POWER BLOCK POWER CONSUMPTION CO2 PROCESSING POWER CONSUMPTI AMMONIA SYNTH. POWER CONSUMPTI UREA SYNTHESIS POWER CONSUMPTI HNO3 SYNTH. POWER CONSUMPTI NH4NO3 SYNTH. POWER CONSUMPTIC COOLING TOWER POWER CONSUMPTIC WATER TREATMENT POWER CONSUMPTIC	
NET PLANT POWER CONSUMPTION =	11.5 MW
WATER BALANCE:	
EVAPORATIVE LOSSES: COOLING TOWER EVAPORATION = ZLD SYSTEM EVAPORATION = TOTAL EVAPORATIVE LOSSES =	807.8 GPM 216.0 GPM 1023.8 GPM
WATER CONSUMED: BOILER FEED WATER MAKEUP = COOLING TOWER MAKEUP = TOTAL WATER CONSUMED =	1223.9 GPM 850.6 GPM 2074.4 GPM
WATER GENERATED: GAS CLEANING CONDENSATE = BOILER BLOWDOWN = COOLING TOWER BLOWDOWN = TOTAL WATER GENERATED = PLANT WATER SUMMARY: NET MAKEUP WATER REQUIRED = WATER CONSUMED / NG FED =	757.6 GPM 1.7 GPM 167.0 GPM 926.3 GPM
	3.94 LB/LB
CO2 BALANCE: CO2 EMITTED (TOTAL) = CO2 EMITTED (TOTAL) = FROM HRSG = FROM REFORMER = FROM GAS CLEANING = (THIS SOURCE IS "SEQUESTRATE CO2 EMITTED / NG FED =	1838. TON/DY 3390. TON/DY
Calculator Block NG-RFMR Hierarchy:	REFORMER
SULFUR REMOVAL CONDITIONS:	
INLET BED TEMPERATURE =	304. °F
PREFORMER CONDITIONS:	
INLET TEMPERATURE = STEAM TO CARBON MOLAR RATIO =	925.°F 5.00
PRIMARY REFORMER CONDITIONS:	
INLET TEMPERATURE =	1292. °F

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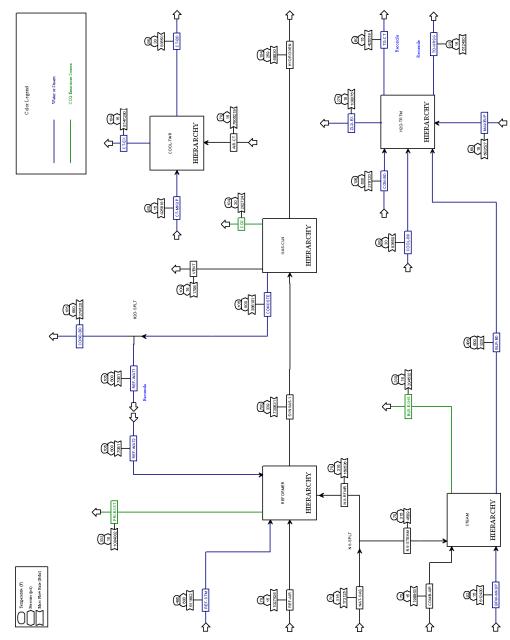
H2 Production from	Natural Gas Summary
STEAM TO CARBON MOLAR RATIO =	4.77
NATURAL GAS BURNED FOR HEAT =	33.56 %
OUTLET TEMPERATURE =	1598.°F
METHANE CONVERSION =	93.8 %

Calculator Block AIRPROPS

HUMIDITY DATA FOR STREAM	PRI-AIR:
HUMIDITY RATIO =	43.5 GRAINS/LB
RELATIVE HUMIDITY =	39.0 %

Appendix A

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Hydrogen from Natural Gas

Appendix A

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	AIR-CT	BFW-MKUP	BLR-BD	BLR-EXHS	CO2
Temperature F Pressure psi Vapor Frac	70 14.7 1	92.4 14.7 0	600	330.4 17.7 1	104 30 1
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	270488.931	33995.058 612430.495 9864.271	45.948 827.772	7204.534	6466.603 282723.87 1.29E+06 -1085.797
Dew Temp	AIR-CT	BFW-MKUP	BLR-BD	BLR-EXHS	CO2
Mass Flow Ib/hr					
H2O O2	48246.87 1.80E+06	612430.495 0	827.772 0	11048.904 28378.321	33.262 0
N2	5.85E+06	0	0	150049.771	0
AR NO	100565.963	0	0	2576.154	0
NO NO2	0 0	0	0	0	0 0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2 CO	53.987 0	0	0 0	0	81.988 17.23
CO2	3535.89	0	0	12478.146	282531.577
H2S	0	0	0	0	0
S02	0	0	0	0.65	0
METHANE	0	0	0	0	59.813
METHANOL	0	0	0	0	0
ETHANE ETHYLENE	0 0	0	0	0	0.001
C	0	0	0	0 0	0 0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS C2H6S	0	0	0	0	0
C2H6S C4H10S	0 0	0	0	0 0	0 0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	-		0	0
Maca Erac	AIR-CT	BFW-MKUP	BLR-BD	BLR-EXHS	CO2
Mass Frac H2O	0.006	1	1	0.054	0
02	0.23	0	0	0.139	0
N2	0.75	0	0	0.734	0
AR	0.013	0	0	0.013	0

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		LII	eenve Bu		1 48	0. 52 01 101
NO	0	C	) 0	0	0	
NO2	0	(			0	
N2O4	0	(				
NH3	0	(			0	
HNO3	0	C			0	
NH4NO3	0	C			0	
H2	0	C	) 0	0	0	
CO	0	C	) 0	0	0	
CO2	0	C	) 0	0.061	0.999	
H2S	0	C			0	
S02	0	C	) 0	0	0	
METHANE	0	C	) 0	0	0	
METHANOL	0	C	) 0	0	0	
ETHANE	0	C	) 0	0	0	
ETHYLENE	0	(			0	
C	0	C			0	
S	0	C			0	
UREA	0	C			0	
CARB	0	0			0	
ZNO	0	0			0	
ZNS	0	0			0	
C2H6S	0	0			0	
C4H10S	0	0			0	
PROPANE	0	(			0	
BUTANE	0	(			0	
PENTANE	0	(			0	
HEXANE		BFW-MKUP		-	0	
Mole Flow lbmol/hr	AIR-CT	DEM-MIKOP	DLR-DD	BLR-EXHS	CO2	
H2O	2678.108	33995.058	45.948	613.307	1.846	
02	56213.492	)			1.840	
N2	208972.785	(			0	
AR	2517.422	(				
NO	2317.422	(				
NO2	0	(				
N2O4	0	0				
NH3	0	(				
HNO3	0	C			0	
NH4NO3	0	C			0	
H2	26.781	C	) 0	0	40.671	
CO	0	C		0		
CO2	80.343	C	) 0	283.531	6419.742	
H2S	0	C				
SO2	0	C	) 0	0.01	0	
METHANE	0	C	) 0			
METHANOL	0	C	) 0	0	0	
ETHANE	0	C				
ETHYLENE	0	C				
C	0	C	) 0	0	0	

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Mole Frac         H2O         0.01         1         1         0.085         0           O2         0.208         0         0.123         0           N2         0.773         0         0         0.743         0           AR         0.009         0         0         0.009         0           NO         0         0         0         0         0         0           NO         0         0         0         0         0         0         0           N204         0         0         0         0         0         0         0           NH3         0         0         0         0         0         0         0           H2         0         0         0         0         0         0         0           CO2         0         0         0         0         0         0         0           H2         0         0         0         0         0         0         0         0           CO2         0         0         0         0         0         0         0         0           CO2         0         0	S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
O2         0.208         0         0.123         0           N2         0.773         0         0         0.743         0           AR         0.009         0         0         0.009         0           NO         0         0         0         0         0         0           NO         0         0         0         0         0         0           NO2         0         0         0         0         0         0           N204         0         0         0         0         0         0           NH3         0         0         0         0         0         0           HH3         0         0         0         0         0         0           HH3         0         0         0         0         0         0           HH4NO3         0         0         0         0         0         0         0           CO2         0         0         0         0         0         0         0           So2         0         0         0         0         0         0         0         0         0 <t< td=""><td>Mole Frac</td><td></td><td></td><td></td><td></td><td></td></t<>	Mole Frac					
N2         0.773         0         0.743         0           AR         0.009         0         0.009         0           NO         0         0         0         0         0           NO         0         0         0         0         0           NO         0         0         0         0         0           NO2         0         0         0         0         0           N204         0         0         0         0         0           NH3         0         0         0         0         0           HNO3         0         0         0         0         0           H2         0         0         0         0         0           CO         0         0         0         0         0           CO2         0         0         0         0         0           METHANE         0         0         0         0         0           METHANOL         0         0         0         0         0           ETHANE         0         0         0         0         0           CARB						
AR         0.009         0         0.009         0         0.009         0           NO         0         0         0         0         0         0           NO2         0         0         0         0         0         0           N204         0         0         0         0         0         0           NH3         0         0         0         0         0         0           HNO3         0         0         0         0         0         0           NH4NO3         0         0         0         0         0         0           H2         0         0         0         0         0         0         0           CO2         0         0         0         0         0         0         0         0           CO2         0			-	-		
NO         0         0         0         0         0           NO2         0         0         0         0         0           N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4N03         0         0         0         0         0           H2         0         0         0         0         0         0           CO         0         0         0         0         0         0         0         0           SO2         0         0         0         0         0         0         0         0         0           METHANE         0         0         0         0         0         0         0         0         0         0         0         0         <						
NO2         0         0         0         0         0           N2O4         0         0         0         0         0           NH3         0         0         0         0         0           HNO3         0         0         0         0         0           NH4NO3         0         0         0         0         0           H2         0         0         0         0         0           CO         0         0         0         0         0           H2         0         0         0         0         0           CO         0         0         0         0         0         0           CO2         0         0         0         0         0         0         0           SO2         0         0         0         0         0         0         0         0           METHANE         0         0         0         0         0         0         0         0           C         0         0         0         0         0         0         0         0         0         0         0 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
N2O4         0         0         0         0         0           NH3         0         0         0         0         0           HNO3         0         0         0         0         0           NH4NO3         0         0         0         0         0           NH4NO3         0         0         0         0         0           H2         0         0         0         0         0           CO         0         0         0         0         0           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0         0         0         0         0           METHANE         0         0         0         0         0           ETHYLENE         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0         0 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
NH3         0         0         0         0         0           HNO3         0         0         0         0         0           NH4NO3         0         0         0         0         0           H2         0         0         0         0         0           H2         0         0         0         0         0           CO         0         0         0         0         0           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0         0         0         0         0           METHANE         0         0         0         0         0           FTHANE         0         0         0         0         0           C         0         0         0         0         0         0           G         0         0         0         0         0         0         0           METHANE         0         0         0         0         0         0         0           CARB         0 <td></td> <td></td> <td>-</td> <td>-</td> <td></td> <td></td>			-	-		
HNO300000NH4NO3000000H2000000CO0000000CO20000000H2S0000000SO20000000METHANE0000000ETHANE0000000C00000000C00000000C00000000CARB00000000ZNO00000000ZNS00000000C4H10S00000000BUTANE00000000PENTANE00000000MWMX28.85618.01518.01528.38943.721000						
NH4NO3         0         0         0         0         0           H2         0         0         0         0         0.006           CO         0         0         0         0         0           CO2         0         0         0         0.039         0.993           H2S         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0         0         0         0         0           METHANOL         0         0         0         0         0           ETHANE         0         0         0         0         0           METHANOL         0         0         0         0         0           ETHANE         0         0         0         0         0           S         0         0         0         0         0         0           VIEA         0         0         0         0         0         0         0           VIEA         0         0         0         0         0         0         0         0         0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
H200000.006CO0000000CO20000000H2S0000000SO20000000METHANE0000000METHANE0000000ETHANE0000000C0000000C0000000CARB0000000ZNO0000000ZNS0000000C4H10S0000000PROPANE0000000BUTANE0000000HEXANE0000000MWMX28.85618.01518.01528.38943.721						
CO00000CO20000.0390.993H2S00000SO200000METHANE00000METHANE00000ETHANE00000C00000ETHYLENE0000C0000CARB0000ZNO0000ZNS0000C4H10S0000PROPANE0000BUTANE0000MWMX28.85618.01518.01528.389AUX28.85618.01518.01528.389						
CO2         0         0         0         0.039         0.993           H2S         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0         0         0         0         0           METHANE         0         0         0         0         0           METHANE         0         0         0         0         0           ETHANE         0         0         0         0         0           ETHANE         0         0         0         0         0           C         0         0         0         0         0         0           ETHYLENE         0         0         0         0         0         0         0           S         0         0         0         0         0         0         0           UREA         0         0         0         0         0         0         0           ZNO         0         0         0         0         0         0         0           ZNO         0         0         0						
H2S       0       0       0       0       0         SO2       0       0       0       0       0         METHANE       0       0       0       0       0       0         METHANOL       0       0       0       0       0       0         ETHANE       0       0       0       0       0       0         ETHYLENE       0       0       0       0       0       0         C       0       0       0       0       0       0       0         UREA       0       0       0       0       0       0       0       0         ZNO       0       0       0       0       0       0       0       0         ZNS       0       0       0       0       0       0       0       0         ZNS       0       0       0       0       0       0       0       0         ZNS       0       0       0       0       0       0       0       0         PROPANE       0       0       0       0       0       0       0       0 <tr< td=""><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr<>		-	-	-	-	-
SO200000METHANE00000.001METHANOL00000ETHANE00000ETHYLENE00000C00000REA00000UREA00000ZNO00000ZNS00000C4H10S00000PROPANE00000BUTANE00000MWMX28.85618.01518.01528.38943.721			-	-		
METHANE0000.001METHANOL00000ETHANE00000ETHYLENE00000C00000S00000UREA00000ZNO00000ZNS00000ZNS00000C4H10S00000PROPANE00000BUTANE00000HXANE00000MWMX28.85618.01518.01528.38943.721						
METHANOL0000ETHANE0000ETHYLENE0000C0000S0000UREA0000CARB0000ZNO0000ZNS0000CH6S0000C4H10S0000PROPANE0000BUTANE0000HEXANE0000MWMX28.85618.01518.01528.38943.721						-
ETHANE0000ETHYLENE0000C0000S0000UREA0000CARB0000ZNO0000ZNS0000C4H10S0000PROPANE0000BUTANE0000MWMX28.85618.01518.01528.389						
ETHYLENE0000C00000S00000UREA00000CARB00000ZNO00000ZNS00000C4H5S00000C4H10S00000PROPANE00000BUTANE00000HEXANE00000MWMX28.85618.01518.01528.38943.721						
C00000S00000UREA00000CARB00000ZNO00000ZNS00000ZH6S00000C4H10S00000PROPANE00000BUTANE00000HEXANE00000MWMX28.85618.01518.01528.38943.721						
S         0         0         0         0         0           UREA         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNO         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0           C2H6S         0         0         0         0         0         0         0           C4H10S         0         0         0         0         0         0         0           PROPANE         0         0         0         0         0         0         0           BUTANE         0         0         0         0         0         0         0           HEXANE         0         0         0         0         0         0         0           MWMX         28.856         18.015         18.015         28.389         43.721						
UREA00000CARB000000ZNO000000ZNS000000C2H6S000000C4H10S000000PROPANE000000BUTANE000000HEXANE000000MWMX28.85618.01518.01528.38943.721						
CARB0000ZNO0000ZNS0000C2H6S0000C4H10S0000PROPANE0000BUTANE0000PENTANE0000HEXANE0000MWMX28.85618.01518.01528.389			-	-		
ZNO         0						
ZNS0000C2H6S00000C4H10S00000PROPANE00000BUTANE00000PENTANE00000HEXANE00000MWMX28.85618.01518.01528.38943.721		-	-	-	-	
C2H6S00000C4H10S000000PROPANE000000BUTANE000000PENTANE000000HEXANE000000MWMX28.85618.01518.01528.38943.721						
C4H10S0000PROPANE0000BUTANE0000PENTANE0000HEXANE0000MWMX28.85618.01518.01528.389						
PROPANE         0         0         0         0         0           BUTANE         0         0         0         0         0         0           PENTANE         0         0         0         0         0         0         0           HEXANE         0         0         0         0         0         0         0           MWMX         28.856         18.015         18.015         28.389         43.721						
BUTANE0000PENTANE0000HEXANE00000MWMX28.85618.01518.01528.38943.721		-	-	-	-	
PENTANE         0         0         0         0         0           HEXANE         0         0         0         0         0         0           MWMX         28.856         18.015         18.015         28.389         43.721						
HEXANE0000MWMX28.85618.01518.01528.38943.721						
MWMX         28.856         18.015         18.015         28.389         43.721				-		
RELHUMID	MWMX	28.856	18.015	18.015	28.389	43.721
	RELHUMID					

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	COMB-AIR	CON-BD	COND-BD	CONDSTE	COOL-BD
Temperature F Pressure psi	70 14.7	104.6 600 0	600	600	86 30 0
Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr	1 6928.996 199942.946 2.68E+06	21042.898 379120.155	21042.898 379120.155	21434.816 386181.143	4635.597
Enthalpy MMBtu/hr Dew Temp	-7.85				
·	COMB-AIR	CON-BD	COND-BD	CONDSTE	COOL-BD
Mass Flow lb/hr	1005 010	270022 477	270022 477	200001 040	02450 127
H2O O2	1235.919 46078.155	379022.477 0			
N2	149960.757		0.002	0.002	71.281
AR	2576.154	0.002			1.545
NO	2570.154	0	0	0	1.545
NO2	0	0	0		Ő
N2O4	0	0	0	0	0
NH3	0	44.763	44.763	45.596	0 0
HNO3	0	0	0	0	0
NH4NO3	0	0			0
H2	1.383	0.253	0.253	0.257	0
CO	0	0.002	0.002	0.002	0
CO2	90.577	52.569	52.569	53.548	0.602
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0.089	0.089	0.091	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0		0
CARB	0	0	0		0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0		0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE		-			-
Mass Frag	COMB-AIR	CON-BD	COND-BD	CONDSTE	COOL-BD
Mass Frac H2O	0.006	1	1	1	0.999
02	0.008				
N2	0.25		0	0	0.001
AR	0.013		0	0	0.001
<i>,</i> 、	0.015	0	0	0	0

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NO	0	0	0	0	0
NO2	0	0	0	0	0
N204	Ő	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0 0	0	0	0	0
C S	0	0	0	0	0 0
UREA	0	0	0	0	0
CARB	0 0	0	0	0	0
ZNO	Ő	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	0	0	0	0
	COMB-AIR	CON-BD	COND-BD	CONDSTE	COOL-BD
Mole Flow Ibmol/hr					
H2O	68.604	21038.945	21038.945	21430.788	4632.186
02	1439.996	0	0	0	0.814
N2	5353.164	0	0	0	2.545
AR NO	64.488 0	0 0	0 0	0 0	0.039 0
NO2	0	0	0	0	0
N204	Ő	0	0	0	0
NH3	Ő	2.628	2.628	2.677	0
HNO3	0	0	0	0	
NH4NO3	0	0	0	0	0
H2	0.686	0.125	0.125	0.128	0
СО	0	0	0	0	0
CO2	2.058	1.194	1.194	1.217	0.014
H2S	0	0	0	0	-
S02	0	0	0	0	0
METHANE	0	0.006	0.006	0.006	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0 0	0	0	0	0 0
C	0	0	0	0	U

Idaho National Laboratory					
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S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0

ZNS	0		0	0	0	0
C2H6S	0		0	0	0	0
C4H10S	0		0	0	0	0
PROPANE	0		0	0	0	0
BUTANE	0		0	0	0	0
PENTANE	0		0	0	0	0
HEXANE	0		0	0	0	0
	COMB-AIR	CON-BD	CONI	D-BD CONI	DSTE C	OOL-BD
Mole Frac	0.01		1	1	1	0.000
H2O	0.01		1	1 0	1 0	0.999
O2 N2	0.208 0.773		0 0	0	0	0 0.001
AR	0.773		0	0	0	
NO	0.009		0	0	0	0 0
NO2	0		0	0	0	0
N02 N2O4	0		0	0	0	0
				-	-	
NH3	0		0	0 0	0 0	0
HNO3	0		0			0
NH4NO3 H2	0 0		0 0	0 0	0 0	0 0
	0		0	0	0	
CO CO2	0		0	0	0	0 0
H2S	0		0	0	0	0
H25 S02	0		0	0	0	0
METHANE	0		0	0	0	0
METHANE	0		0	0	0	0
ETHANE	0		0	0	0	0
ETHYLENE	0		0	0	0	0
C	0		0	0	0	0
S	0		0	0	0	0
UREA	0		0	0	0	0
CARB	0		0	0	0	0
ZNO	0		0	0	0	0
ZNS	0		0	0	0	0
C2H6S	0		0	0	0	0
C4H10S	0		0	0	0	0
PROPANE	0		0	0	0	0
BUTANE	0		0	0	0	0
PENTANE	0		0	0	0	0
HEXANE	0		0	0	0	0
MWMX	28.856			18.017	0 18.017	18.023
RELHUMID	20.000	10.0	1/	10.01/	10.01/	10.025
RELIGHID						

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	CT-BD	CT-EX	CT-MKUP	HYDROGEN	MAKEUP
Temperature F Pressure psi Vapor Frac	86 30 0	104.1 14.7 0.996	60 14.7 0	104 259.29 1	60 14.7 0
Mole Flow Ibmol/hr	4635.597	289771.942	23625.388	25664.228	37891.551
Mass Flow lb/hr	83549.613		425617.984		682626.908
Volume Flow cuft/hr	1343.362			601993.862	12820.295
Enthalpy MMBtu/hr Dew Temp	-568.888	-2315.3	-2912.212	-9.599	-4699.571
	CT-BD	CT-EX	CT-MKUP	HYDROGEN	MAKEUP
Mass Flow lb/hr	00450 407	404000 505	125617.004	0.460	
H2O O2	83450.127 26.057	404232.525 1.80E+06	425617.984 0		682626.908
N2	71.281	5.84E+06	0	2135.195	0 0
AR	1.545		0	2135.155	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2 CO	0	53.979 0	0 0	50689.51 0	0 0
CO2	0.602	3451.702	0	0	0
H2S	0.002	0	0	0	0
S02	0	0	0	0	0 0
METHANE	0	0	0	7105.005	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S UREA	0	0	0 0	0 0	0 0
CARB	0	0	0	0	0
ZNO	0	0	0	0	Ő
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0 CT-BD			0 HYDROGEN	0 Μακεί ιρ
Mass Frac		CILX		MEROGEN	MAREON
H2O	0.999	0.05	1	0	1
02	0	0.22	0		0
N2	0.001			0.036	0
AR	0	0.012	0	0	0

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NO NO2 N2O4 NH3	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0.846	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S SO2	0 0	0 0	0 0	0	0 0
METHANE	0	0	0	0.119	0
METHANOL	0	0	0	0.119	0
ETHANE	0	Ő	0 0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS C2H6S	0 0	0 0	0 0	0	0 0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	Ő	0	0	0
PENTANE	0	0 0	0	0	0
HEXANE	0	0	0	0	0
	CT-BD CT-E>	<	CT-MKUP	HYDROGEN	MAKEUP
Mole Flow lbmol/hr					
H2O		38.315	23625.388	0.026	37891.551
02		99.578	0	0	0
N2 AR	2.545 2086 0.039 2	2512.01	0 0	76.22 0	0 0
NO	0.039 2	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	26.777	0	25145.103	0
СО	0	0	0	0	0
CO2	0.014	78.43	0	0	0
H2S	0	0	0	0	0
SO2 METHANE	0 0	0 0	0 0	0 442.879	0 0
METHANE	0	0	0	442.879	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0

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S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	0	0	0	0
	CT-BD CT-EX	CT-MK	(UP ł	HYDROGEN MA	KEUP
Mole Frac					
H2O		1 077	1	0	1

	CT-BD	CT-EX	CT-MKUP	HYDROGEN	MAKEUP
Mole Frac					
H2O	0.999	0.077	1	0	1
02	0	0.194	0	0	0
N2	0.001	0.72		0.003	0
AR	0	0.009	0	0	0
NO	0	0	0	0	0
NO2	0	-	0	-	0
N2O4	0	0	0	0	0
NH3	0	-	0	-	0
HNO3	0		0		0
NH4NO3	0		0	0	0
H2	0		0		
CO	0		0		
CO2	0		-		0
H2S	0	-		-	0
S02	0	-	0	-	0
METHANE	0		0		
METHANOL	0		0		
ETHANE	0				
ETHYLENE	0	-	0	-	0
С	0		0		0
S	0		0		0
UREA	0		0		0
CARB	0		0		
ZNO	0		0		0
ZNS	0		0	-	0
C2H6S	0	-	0		0
C4H10S	0	-	0	-	0
PROPANE	0		0		0
BUTANE	0		0	0	0
PENTANE	0		0	0	0
HEXANE	0		0	-	0
MWMX	18.023	28.116	18.015	2.335	18.015
RELHUMID					

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	NAT-GAS	NG-RFMR	NG-STEAM	PRI-EXST	REF-AIR
Temperature F	70	70	70	333	70
Pressure psi	314.7	314.7	314.7	17.7	14.7
Vapor Frac	1	1	1	1	1
Mole Flow Ibmol/hr	10076.025	9808.941	267.084	39007.232	35608.693
Mass Flow Ib/hr	173125				1.03E+06
Volume Flow cuft/hr	172389.296				1.38E+07
Enthalpy MMBtu/hr	-330.118			-1249.957	-40.344
Dew Temp					
	NAT-GAS	NG-RFMR	NG-STEAM	PRI-EXST	REF-AIR
Mass Flow lb/hr					
H2O	0	0	0	127210.398	6351.491
02	32.234	31.38	0.854	18723.078	236799.503
N2	3358.149	3269.135	89.014	771758.021	770660.899
AR	0	0	0	13239.072	13239.072
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	7.107
CO	0	0	0	0	0
CO2	1108.346		29.379	153145.658	465.485
H2S	1.717	1.671	0.046	0	0
SO2	0	-	0	8.012	0
METHANE	151249.661 0	147240.507	4009.153 0	0	0
METHANOL ETHANE	11359.138	0 11058.043	301.095	0 0	0 0
ETHYLENE	11559.158			0	0
C	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0 0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	1.878	1.828	0.05	0	0
C4H10S	27.256	26.534	0.722	0	0
PROPANE	4086.75	3978.423	108.327	0	0
BUTANE	1522.335	1481.983	40.352	0	0
PENTANE	290.726	283.02	7.706	0	0
HEXANE	86.812	84.511			0
	NAT-GAS	NG-RFMR	NG-STEAM	PRI-EXST	REF-AIR
Mass Frac					
H2O	0	0	0	0.117	0.006
02	0			0.017	0.23
N2	0.019			0.712	0.75
AR	0	0	0	0.012	0.013

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NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0

NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0.006	0.006	0.006	0.141	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0.874	0.874	0.874	0	0
METHANOL	0	0	0	0	0
ETHANE	0.066	0.066	0.066	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0.024	0.024	0.024	0	0
BUTANE	0.009	0.009	0.009	0	0
PENTANE	0.002	0.002	0.002	0	0
HEXANE	0.001	0.001	0.001	0	0
HEXANE	0.001 NAT-GAS	0.001 NG-RFMR	0.001 NG-STEAM	0 PRI-EXST	0 REF-AIR
				-	-
Mole Flow lbmol/hr		NG-RFMR		PRI-EXST	REF-AIR
Mole Flow lbmol/hr H2O	NAT-GAS 0	NG-RFMR 0	NG-STEAM 0	PRI-EXST 7061.25	REF-AIR 352.561
Mole Flow Ibmol/hr H2O O2	NAT-GAS 0 1.007	NG-RFMR 0 0.981	NG-STEAM 0 0.027	PRI-EXST 7061.25 585.118	REF-AIR 352.561 7400.262
Mole Flow Ibmol/hr H2O O2 N2	NAT-GAS 0 1.007 119.876	NG-RFMR 0 0.981 116.699	NG-STEAM 0 0.027 3.178	PRI-EXST 7061.25 585.118 27549.523	REF-AIR 352.561 7400.262 27510.359
Mole Flow lbmol/hr H2O O2 N2 AR	NAT-GAS 0 1.007 119.876 0	NG-RFMR 0 0.981 116.699 0	NG-STEAM 0 0.027 3.178 0	PRI-EXST 7061.25 585.118 27549.523 331.408	REF-AIR 352.561 7400.262 27510.359 331.408
Mole Flow Ibmol/hr H2O O2 N2	NAT-GAS 0 1.007 119.876	NG-RFMR 0 0.981 116.699	NG-STEAM 0 0.027 3.178	PRI-EXST 7061.25 585.118 27549.523	REF-AIR 352.561 7400.262 27510.359
Mole Flow Ibmol/hr H2O O2 N2 AR NO	NAT-GAS 0 1.007 119.876 0 0	NG-RFMR 0.981 116.699 0 0	NG-STEAM 0 0.027 3.178 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2	NAT-GAS 0 1.007 119.876 0 0 0	NG-RFMR 0.981 116.699 0 0 0	NG-STEAM 0 0.027 3.178 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3	NAT-GAS 0 1.007 119.876 0 0 0 0 0	NG-RFMR 0 0.981 116.699 0 0 0 0 0	NG-STEAM 0.027 3.178 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0	NG-RFMR 0.981 116.699 0 0 0 0 0 0 0	NG-STEAM 0.027 3.178 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-RFMR 0.981 116.699 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0	NG-RFMR 0.981 116.699 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-STEAM 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-RFMR 0.981 116.699 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0 25.184	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 0 0 24.517	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 3479.808	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-RFMR 0.981 116.699 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 3479.808 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 25.184 0.05 0	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 0 0 24.517 0.049 0	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 3479.808 0 0.125	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 25.184 0.05	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 0 0 24.517 0.049	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 3479.808 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANOL	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 25.184 0.05 0 9427.908	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 0 24.517 0.049 0 9178.003	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 3479.808 0 0.125 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANOL ETHANE	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 0 25.184 0.05 0 9427.908 0 377.761	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 24.517 0.049 0 9178.003 0 367.748	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANOL	NAT-GAS 0 1.007 119.876 0 0 0 0 0 0 0 0 0 0 25.184 0.05 0 9427.908 0	NG-RFMR 0 0.981 116.699 0 0 0 0 0 0 0 24.517 0.049 0 9178.003 0	NG-STEAM 0 0.027 3.178 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PRI-EXST 7061.25 585.118 27549.523 331.408 0 0 0 0 0 0 0 0 0 0 0 0 3479.808 0 0.125 0 0 0	REF-AIR 352.561 7400.262 27510.359 331.408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	
ZNS	0	0	0	0	-
C2H6S	0.03	-	0.001	0	
C4H10S				0	
	0.302		0.008	-	-
PROPANE	92.677	90.221	2.457	0	-
BUTANE	26.191	25.497	0.694		-
PENTANE	4.029		0.107		
HEXANE	1.007	0.981	0.027	0	
	NAT-GAS	NG-RFMR	NG-STEAM	PRI-EXST	REF-AIR
Mole Frac					
H2O	0	0	0	0.181	0.01
02	0	0	0	0.015	0.208
N2	0.012	0.012	0.012	0.706	0.773
AR	0	0	0	0.008	0.009
NO	0			0	
NO2	0	0	0	0	
N2O4	0	0	0 0	0	
NH3	0	0	0	0	-
HNO3	0	0	0	0	-
	0		0		
NH4NO3		0		0	
H2	0	0	0	0	
CO	0	0	0	0	-
CO2	0.002	0.002	0.002	0.089	
H2S	0		0	0	
S02	0	-	0	0	-
METHANE	0.936	0.936	0.936	0	0
METHANOL	0	0	0	0	0
ETHANE	0.037	0.037	0.037	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0		0	0	
ZNO	0	0	0	0	-
ZNS	0	0	0	0	
C2H6S	0	0	0	0	
C4H10S	0	0	0	0	-
	-	-	-	-	-
PROPANE	0.009	0.009	0.009	0	
BUTANE	0.003	0.003	0.003	0	
PENTANE	0		0	0	
HEXANE	0	0	0	0	-
MWMX	17.182	17.182	17.182	27.792	28.856
RELHUMID					

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	REF-STM	REF-WAT1	REF-WAT2	SYNGAS-1	то-ст
Temperature F Pressure psi Vapor Frac	485.2 600 1	104.6 600 0		700 338.59 1	60 14.7 0
Mole Flow Ibmol/hr	33949.11	391.917			23625.388
Mass Flow Ib/hr	611602.723		7060.989	730631.091	425617.984
Volume Flow cuft/hr	486069.137				7993.456
Enthalpy MMBtu/hr Dew Temp	-3447.229				-2930.183
Mass Flow h/hr	REF-STM	REF-WAT1	REF-WAT2	SYNGAS-1	то-ст
Mass Flow lb/hr H2O	611602.723	7059.169	7059 169	446631.689	425617 984
02	011002.725			0000000	425017.904
N2	0	0	0	2129.142	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0.834		52.96	0
HNO3 NH4NO3	0 0	0 0	0	0 0	0 0
H2	0	0.005	0.005		0
CO	0	0.003			0
CO2	0	0.979		135889.567	0
H2S	0	0		0	0
S02	0	0	0	0	0
METHANE	0	0.002	0.002	5981.418	0
METHANOL	0	0			0
ETHANE	0	0	0	0.11	0
ETHYLENE	0	0	0	0	0
C S	0	0	0	0	0
S UREA	0 0	0 0	0 0	0 0	0 0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0 REF-STM	0 Ref-W/AT1	0 REF-WAT2	0 SVNGAS-1	0 TO-CT
Mass Frac				JINGAJ-1	
H2O	1	1	1	0.611	1
02	Ō	0	0	0	0
N2	0	0	0	0.003	0
AR	0	0	0	0	0

Idaho National Laboratory

Idano National Laboratory		Ida	ntifier:	TEV-693	
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NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0.061	0
CO	0	0	0	0.131	0
CO2	0	0	0	0.186	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0.008	0
METHANOL	0	0	0	0	0
	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C S	0	0 0	0 0	0	0
S UREA	0 0	0	0	0 0	0 0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	õ	0	0	0	0
PENTANE	õ	Ö	0 0	0	0
HEXANE	0	0	0	0	0
	-	-WAT1 I	REF-WAT2	SYNGAS-1	то-ст
Mole Flow lbmol/hr					
H2O	33949.11 3	391.843	391.843	24791.826	23625.388
02	0	0	0	0	0
N2	0	0	0	76.004	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0.049	0.049	3.11	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0.002	0.002	22073.308	0
CO	0	0	0	3407.629	0
CO2	0	0.022	0.022	3087.712	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	372.842	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0.004	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0

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S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	REF-STM	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Frac						
H2O		1	1	1	0.461	1
02 N2		0 0	0 0	0 0	0 0.001	0
AR		0	0	0	0.001	0 0
NO		0	0	0	0	0
NO2		0	0	0	0	0
N2O4		0	0	0	0	0
NH3		0	0	0	0	0
HNO3		0	0	0	0	0
NH4NO3		0	0	0	0	0
H2		0	0	0	0.41	0
CO		0	0	0	0.063	0
CO2 H2S		0	0 0	0 0	0.057	0 0
H25 S02		0 0	0	0	0	0
METHANE		0	0	0	0.007	0
METHANOL		Ö	0 0	0	0.007	0
ETHANE		0	0	0	0	0
ETHYLENE		0	0	0	0	0
С		0	0	0	0	0
S		0	0	0	0	0
UREA		0	0	0	0	0
CARB		0	0	0	0	0
ZNO		0	0	0	0	0
ZNS C2H6S		0 0	0 0	0 0	0	0
C4H10S		0	0	0	0	0
PROPANE		õ	0 0	0	0	0
BUTANE		0	0	0	0	0
PENTANE		0	0	0	0	0
HEXANE		0	0	0	0	0
MWMX	18.0	)15	18.017	18.017	13.577	18.015
RELHUMID						

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	TO-HRSG	VENT	ZLD-EX
Temperature F Pressure psi	92.8 14.7 0	104 14.7 0	275 14.7
Vapor Frac Mole Flow Ibmol/hr	33992.016	99.68	1 5998.591
Mass Flow lb/hr	612430.495		
Volume Flow cuft/hr	13280.745	34.276	3.20E+06
Enthalpy MMBtu/hr Dew Temp	-4193.74	-12.278	-614.532
Maca Flaw, lb/br	TO-HRSG	VENT	ZLD-EX
Mass Flow lb/hr H2O	612262.904	1795.76	108046.395
02	22.149		3.909
N2	60.592	0	10.693
AR	1.314	0	0.232
NO	0	0	0
NO2	0	0	0
N2O4	0	0	0
NH3	38.048	0	6.714
HNO3	0	0	0
NH4NO3 H2	0 0.215	0	0 0.038
CO	0.215	0 0	0.038
CO2	45.195	0	7.976
H2S	0	0	0
S02	0	0	0
METHANE	0.076	0	0.013
METHANOL	0	0	0
ETHANE	0	0	0
ETHYLENE	0	0	0
С	0	0	0
S UREA	0 0	0	0 0
CARB	0	0 0	0
ZNO	0	0	0
ZNS	0	0	0
C2H6S	0	0	0
C4H10S	0	0	0
PROPANE	0	0	0
BUTANE	0	0	0
PENTANE	0	0	0
HEXANE	0 TO-HRSG	0 VENT	
Mass Frac	D-UK30		ZLD-EX
H2O	1	1	1
02	0	0	- 0
N2	0	0	0
AR	0	0	0

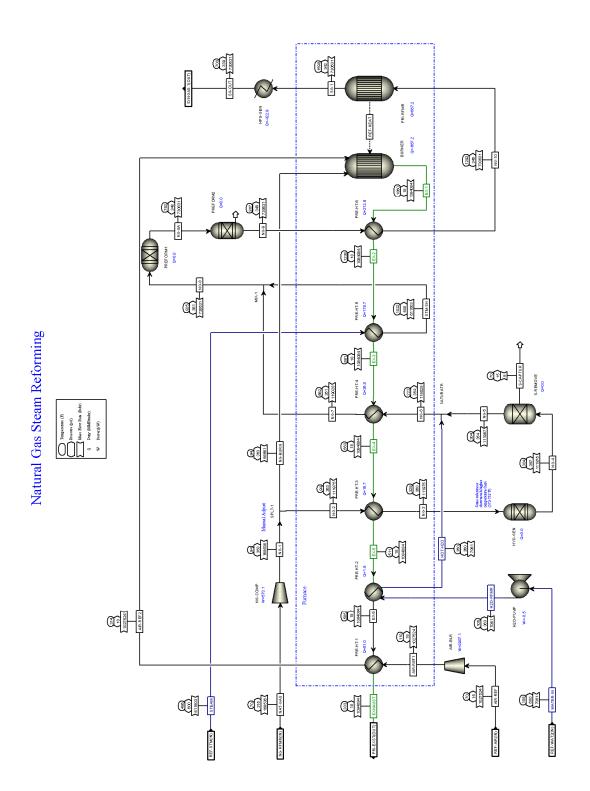
NUCLEAD INTECDATED HVDDOCEN	Identifier:	TEV-693	
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HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANOL ETHANE ETHYLENE C S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE		
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANE ETHYLENE	-	ZLD-EX 5997.486 0.122 0.382 0.006 0 0 0 0 0 0 0 0 0 0 0 0 0

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S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	TO-HRSG	0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Frac H2O		1	1	1
02		0	0	0
N2		0	0	0
AR		0	0	0
NO NO2		0 0	0	0
N2O4		0	0 0	0 0
NH3		0	0	0
HNO3		0	0	0
NH4NO3		0	0	0
H2		0	0	0
CO CO2		0 0	0 0	0 0
H2S		0	0	0
S02		0	0	0
METHANE		0	0	0
METHANOL		0	0	0
ETHANE ETHYLENE		0 0	0 0	0 0
C		0	0	0
S		0	0	0
UREA		0	0	0
CARB ZNO		0 0	0 0	0 0
ZNO		0	0	0
C2H6S		Õ	0	0
C4H10S		0	0	0
PROPANE		0	0	0
BUTANE PENTANE		0 0	0 0	0 0
HEXANE		0	0	0
MWMX	18.0	-	18.015	18.017
RELHUMID				

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	AIR-REF	AIR-REF1	AIR-REF2	EX-1	EX-2
Temperature F Pressure psi	70 14.7			17.7	1238.4 17.7
Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr	1 35608.693 1.03E+06	1.03E+06		39007.232 1.08E+06	1 39007.232 1.08E+06
Volume Flow cuft/hr Enthalpy MMBtu/hr	1.38E+07 -40.344 AIR-REF	-30.425		-753.822	4.02E+07 -966.695 EX-2
Mass Flow lb/hr H2O	6351.491			127210.398	
O2 N2	770660.899		770660.899	771758.021	
AR NO NO2	13239.072 0 0		13239.072 0 0	0	13239.072 0 0
N204 NH3	0	0	0		0
HNO3 NH4NO3	0 0	0	0 0	0	0
H2 CO CO2	7.107 0 465.485	7.107 0 465.485	7.107 0 465.485	-	0 0 153145.658
H2S SO2	0	0	0	0	0 8.012
METHANE METHANOL ETHANE	0 0 0	0 0 0	0 0 0		0 0 0
ETHYLENE C	0	0	0	0	0
S UREA	0	0	0		0
CARB ZNO ZNS	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
C2H6S C4H10S	0	0	0 0	0 0	0 0
PROPANE BUTANE	0 0 0	0 0 0	0	0	0
PENTANE HEXANE	0 AIR-REF	0 AIR-REF1	0 0 AIR-REF2	0 0 EX-1	0 0 EX-2
Mass Frac H2O	0.006	0.006	0.006		0.117
O2 N2	0.23 0.75		0.75	0.712	0.017 0.712
AR NO	0.013 0				0.012 0

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		•			
NO2	0	0	0	0	0
NO2 N2O4	0	0	0	0	0
NH3	0	0	0	0	0 0
HNO3	0	0	0	0 0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO CO2	0		0	0.141	0.141
		0			
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	0	0	0	0
	AIR-REF A	IR-REF1 A	AIR-REF2	EX-1 I	EX-2
Mole Flow lbmol/hr					
H2O	352.561	352.561	352.561	7061.25	7061.25
02	7400.262	7400.262	7400.262	585.118	585.118
N2	27510.359	27510.359	27510.359	27549.523	27549.523
AR	331.408	331.408	331.408	331.408	331.408
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	3.526	3.526	3.526	0	0
CO	0	0	0	0	0
CO2	10.577	10.577	10.577	3479.808	3479.808
H2S	0	0	0	0	0
S02	0	0	0	0.125	0.125
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0

UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE		) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
HEXANE					
HEXANE Mole Frac H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANE ETHYLENE C S UREA CARB ZNO ZNS	AIR-REF 0.01 0.208 0.773 0.009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	AIR-REF1  . 0.01 3 0.208 3 0.773 3 0.009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	AIR-REF2 0.01 0.208 0.773 0.009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	EX-1 0.181 0.015 0.706 0.008 0 0 0 0 0 0 0 0 0 0 0 0 0	0 EX-2 0.181 0.015 0.706 0.008 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE		) 0 ) 0 ) 0 ) 0 ) 0	0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0

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	EX-3	EX-4	EX-5	EX-6	EXHAUST
Temperature F Pressure psi	680.8 17.7	<b>17.7</b>	17.7	504.8 17.7	333 17.7
Vapor Frac Mole Flow Ibmol/hr	: 39007.232			1 39007.232	1 39007.232
Mass Flow Ib/hr	1.08E+06				1.08E+06
Volume Flow cuft/hr	2.70E+07				1.87E+07
Enthalpy MMBtu/hr	-1145.434	-1181.278	-1197.012	-1198.928	-1249.957
	EX-3	EX-4	EX-5	EX-6	EXHAUST
Mass Flow lb/hr					
H2O		3 127210.398			
02	18723.078			18723.078	18723.078
N2			771758.021		
AR NO	13239.072			13239.072 0	13239.072 0
NO2	(			0	0
N2O4	(			0	0
NH3	(			0	0
HNO3	(	) 0	0	0	0
NH4NO3	(	) 0	0	0	0
H2	(	) 0	0	0	0
CO	(		-	0	0
CO2	153145.658			153145.658	153145.658
H2S	)			0	0
SO2	8.012			8.012	8.012
METHANE METHANOL	(			0 0	0 0
ETHANE	(			0	0
ETHYLENE	(			0	0
C	(			0	0
S	(			0	0
UREA	(	) 0	0	0	0
CARB	(	) 0	0	0	0
ZNO	(			0	0
ZNS	(			0	0
C2H6S	(			0	0
C4H10S PROPANE	(			0 0	0 0
BUTANE	(			0	0
PENTANE	(			0	0
HEXANE	(			0	0
	EX-3	EX-4	EX-5	EX-6	EXHAUST
Mass Frac					
H2O	0.117			0.117	0.117
02	0.017			0.017	0.017
N2	0.712			0.712	0.712
AR	0.012			0.012	0.012
NO	(	) 0	0	0	0

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<b>PRODUCTION</b> A	ANALYSIS			tive Date:	05/15/10	Page: 5	4 of 151
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NO2 N2O4	0 0		0 0	0 0		0 0	
NH3	0		0	0		0	
HNO3	0		Ō	0		0	
NH4NO3	0		0	0		0	
H2	0		0	0	0	0	
CO	0		0	0	0	0	
CO2	0.141		0.141	0.141	0.141	0.141	
H2S	0		0	0		0	
SO2	0		0	0		0	
METHANE	0		0	0		0	
METHANOL	0		0	0		0	
ETHANE	0		0	0		0	
ETHYLENE	0		0	0		0	
C S	0 0		0 0	0 0		0 0	
UREA	0		0	0		0	
CARB	0		0	0		0	
ZNO	0		Õ	0		0	
ZNS	0		0	0		0	
C2H6S	0		0	0	0	0	
C4H10S	0		0	0		0	
PROPANE	0		0	0	0	0	
BUTANE	0		0	0		0	
PENTANE	0		0	0		0	
HEXANE	0		0	0	-	0	
	EX-3	EX-4	E	X-5	EX-6	EXHAUST	
Mole Flow Ibmol/hr	7061.05	70	C1 25	7061 25	7061.25	7061.05	
H2O O2	7061.25		61.25	7061.25			
N2	585.118 27549.523		5.118 9.523	585.118 27549.523			
AR	331.408		9.525 1.408	331.408			
NO	0		1.408 0	0		0	
NO2	0		0	0			
N2O4	0		õ	0			
NH3	0		0	0			
HNO3	0		0	0	0	0	
NH4NO3	0		0	0	0	0	
H2	0		0	0	0	0	
CO	0		0	0	0	0	
CO2	3479.808		9.808	3479.808			
H2S	0		0	0	-		
SO2	0.125		0.125	0.125			
METHANE	0		0	0			
METHANOL	0		0	0	-		
ETHANE ETHYLENE	0 0		0 0	0 0			
C	0		0	0			
S	0		0	0			
5	0		0	0	0	0	

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	EX-3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
Mole Frac						001
H2O		0.181	0.181	0.181	0.181	0.181
02		0.015	0.015	0.015	0.015	0.015
N2		0.706	0.706	0.706	0.706	0.706
AR		0.008	0.008	0.008	0.008	0.008
NO		0.000	0.000	0.000	0.000	0.000
NO2		0	0	0	0	0
N2O4		0	0	0	0	0
NH3		0	0	0	0	0
HNO3		0	0	0	0	0
NH4NO3		0	0	0	0	0
H2		0	0	0	0	0
CO		0	0	0	0	0
CO2		0.089	0.089	0.089	0.089	0.089
H2S		0.089	0.009	0.009	0.009	0.089
S02		Ő	0	0	0	0
METHANE		0	0	0	0	0
METHANOL		0	0	0	0	Ö
ETHANE		0	0	0	0	0
ETHYLENE		0	0	0	0	Õ
C		0	0	0	0	0
S		0	0	0	0	0
UREA		0	0	0	0	0
CARB		0	0	0	0	0
ZNO		0	0	0	0	0
ZNS		0	0	0	0	0
C2H6S		0	0	0	0	0
C4H10S		0	0	0	0	0
PROPANE		0	0	0	0	0
BUTANE		0	0	0	0	0
PENTANE		0	0	0	0	0
HEXANE		0	0	0	0	0

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	H2O-RFMR	HOT-H2O	LIQ	NAT-GAS	NG-1
Temperature F Pressure psi Vapor Frac	105 362.59 0	350 359.59 0	347.59	70 314.7 1	94.2 362.59 1
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr	391.917	391.917 7060.989 154.085	0 0 0	9808.941 168536 167819.797	9808.941 168536
Enthalpy MMBtu/hr	-48.255 H2O-RFMR	-46.34 HOT-H2O	LIQ	-321.367 NAT-GAS	-319.412 NG-1
Mass Flow lb/hr					
H2O		7059.169	0	0	0
02	0	0	0	31.38	31.38
N2	0	0	0	3269.135	3269.135
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0.834	0.834	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0.005	0.005	0	0	0
CO	0	0	0	0	0
CO2	0.979	0.979	0	1078.967	1078.967
H2S	0	0	0	1.671	1.671
SO2	0 0.002	0 0.002	0	0 147240.507	0
METHANE METHANOL	0.002	0.002	0 0	14/240.50/	147240.507
ETHANE	0	0	0	11058.043	0 11058.043
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0 0	0	0	0	Ő
ZNS	0	0	0	0	0
C2H6S	0	0	0	1.828	1.828
C4H10S	0	0	0	26.534	26.534
PROPANE	0	0	0	3978.423	3978.423
BUTANE	0	0	0	1481.983	1481.983
PENTANE	0	0	0	283.02	283.02
HEXANE	0	0	0	84.511	84.511
	H2O-RFMR	HOT-H2O	LIQ	NAT-GAS	NG-1
Mass Frac					
H2O	1	1		0	0
02	0	0		0	0
N2	0	0		0.019	0.019
AR	0	0		0	0
NO	0	0		0	0

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NUCLEAR-INTEGRAT	ευ πλυσο		Identifie		EV-693	
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				Date. 0.	0/10/10	1 age. 57 01 151
NO2	0	0			0	h
NO2 N2O4	0	0				2
	0	0				2
NH3	0	0				0
HNO3	0	0				0
NH4NO3	0	0				2
H2	0	0				2
CO	0	0		0.00		0
CO2	0	0		0.00		
H2S	0	0				2
S02	0	0		-		2
METHANE	0	0		0.87		
METHANOL	0	0				2
ETHANE	0	0		0.06		
ETHYLENE	0	0			0 (	0
C	0	0			0 0	0
S	0	0			0 (	0
UREA	0	0			0 0	0
CARB	0	0			0 0	C
ZNO	0	0			0 0	2
ZNS	0	0			0 (	C
C2H6S	0	0			0 (	0
C4H10S	0	0			0 (	0
PROPANE	0	0		0.02	0.024	4
BUTANE	0	0		0.00	0.009	Ð
PENTANE	0	0		0.00	0.002	2
HEXANE	0	0		0.00	0.00	1
	H2O-RFMR	HOT-H2O	LIQ	NAT-GAS	NG-1	
Mole Flow lbmol/hr						
H2O	391.843	391.843	0			2
02	0	0	0	0.98	0.98	1
N2	0	0	0	116.69	99 116.699	9
AR	0	0	0			D
NO	0	0	0		0 0	D
NO2	0	0	0		0 0	0
N2O4	0	0	0			D
NH3	0.049	0.049	0		0 0	D
HNO3	0	0	0		0 (	C
NH4NO3	0	0	0			0
H2	0.002	0.002	0		0 (	C
СО	0	0	0		0 (	2
CO2	0.022	0.022	0	24.51	24.51	7
H2S	0	0	0	0.04		
S02	0	0	0	0.0		0
METHANE	0	0	0	9178.00		
METHANOL	0	0	0	51,0100		0
ETHANE	0	0	0	367.74		
ETHYLENE	0	0	0	507.77		0
C	0	0	0			2
S	0	0	0			5
5	0	0	0		-	-

UREA CARB ZNO ZNS C2H6S C4H10S PROPANE	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0.029 0.294 90.221	0 0 0 0.029 0.294 90.221
BUTANE	0	0	0	25.497	25.497
PENTANE	0	0	0	3.923	3.923
HEXANE	0 0	õ	0	0.981	0.981
	H2O-RFMR HOT	-	-	AT-GAS NG	
Mole Frac					-
H2O	1	1	0	0	0
02	0	0	0	0	0
N2	0	0	0	0.012	0.012
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0.002	0.002
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0.936	0.936
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0.037	0.037
ETHYLENE	0	0	0	0	0
C S	0	0	0	0	0
S UREA	0 0	0 0	0 0	0 0	0 0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	õ	0	Ö
PROPANE	0	0	Õ	0.009	0.009
BUTANE	0	0	0	0.003	0.003
PENTANE	0	0	Õ	0	0
HEXANE	0	0	0	0	0
	-			-	-

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	NG-2	NG-3	NG-4	NG-5	NG-6
Temperature F Pressure psi Vapor Frac	94.2 362.59 1	329 359.59 1	303.9 356.59 1	303.9 353.59 1	221.6 353.59 0.999
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr	6517.06 111975.318 101334.46	6517.06	6549.886 111975.318 148837.353	6549.638	6941.555 119028.368 139479.274
Enthalpy MMBtu/hr	-212.217 NG-2	-196.485 NG-3	-196.485 NG-4		-242.838 NG-6
Mass Flow lb/hr H2O	0	0	0	0	7059.169
O2 N2	20.849 2172.013	20.849 2172.013	20.849 2172.013		20.849 2172.013
AR NO	0	0	0	0	0
NO2 N2O4 NH3	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0.834
HNO3 NH4NO3	0	0	0	0	0.054
H2 CO	0	0	65.738 912.51	65.738 912.51	65.743 912.51
CO2 H2S	716.866 1.11	716.866 1.11	0 0	0 0	0.979 0
SO2 METHANE	0 97826.593	0 97826.593	0 97565.276	0 97565.276	0 97565.278
METHANOL ETHANE ETHYLENE	0 7346.964 0	0 7346.964 0	0 7347.551 0	0 7347.551 0	0 7347.551 0
C	0	0	0 7.939	0	0
UREA CARB	0 0	0 0	0 0	0 0	0 0
ZNO ZNS	0 0	0 0	0	0	0
C2H6S C4H10S PROPANE	1.215 17.629 2643.264	1.215 17.629 2643.264	0 0 2643.264	0 0 2643.264	0 0 2643.264
BUTANE PENTANE	984.629 188.038	984.629 188.038	995.99 188.038	995.99 188.038	995.99 188.038
HEXANE	56.149 NG-2	56.149 NG-3	56.149 NG-4	56.149 NG-5	56.149 NG-6
Mass Frac H2O	0	0	0	0	0.059
O2 N2 AR	0 0.019 0	0 0.019 0	0 0.019	0 0.019	0 0.018
AR NO	0	0	0 0	0 0	0 0

Idaho National Laboratory		Identi	fier:	TEV-693		
NUCLEAR-INTEGRATED HYDROGEN		EN Revis		1		
<b>PRODUCTION</b> A	NALYSIS			05/15/10	Dage: 6	0 of 151
		Life	live Date.	03/13/10	I age. 0	5 01 151
NO2	0	0	0	0	0	
N2O4	0	0	0	0	0	
NH3	0	0	0	0	0	
HNO3 NH4NO3	0 0	0 0	0 0	0 0	0 0	
H2	0	0	0.001	0.001	0.001	
CO	0	0	0.001	0.008	0.001	
CO2	0.006	0.006	0	0	0	
H2S	0	0	0	0	0	
S02	0	0	0	0	0	
METHANE	0.874	0.874	0.871	0.871	0.82	
METHANOL	0	0	0	0	0	
ETHANE	0.066	0.066	0.066	0.066	0.062	
ETHYLENE	0	0	0	0	0	
C	0	0	0	0	0	
S	0	0	0	0	0	
UREA	0	0	0	0	0	
CARB	0	0	0	0	0	
ZNO ZNS	0 0	0 0	0 0	0	0 0	
C2H6S	0	0	0	0	0	
C4H10S	0	0	0	0	0	
PROPANE	0.024	0.024	0.024	0.024	0.022	
BUTANE	0.009	0.009	0.009	0.009	0.008	
PENTANE	0.002	0.002	0.002	0.002	0.002	
HEXANE	0.001	0.001	0.001	0.001	0	
			IG-4	NG-5	NG-6	
Mole Flow Ibmol/hr						
H2O	0	0	0	0	391.843	
02	0.652	0.652	0.652	0.652	0.652	
N2	77.535	77.535	77.535	77.535	77.535	
AR	0	0	0	0	0	
NO	0	0	0	0	0	
NO2	0	0	0	0	0	
N2O4 NH3	0 0	0 0	0 0	0 0	0 0.049	
HNO3	0	0	0	0	0.049	
NH4NO3	0	0	0	0	0	
H2	0	0	32.61	32.61	32.612	
CO	0	0	32.578	32.578	32.578	
CO2	16.289	16.289	0	0	0.022	
H2S	0.033	0.033	0	0	0	
SO2	0	0	0	0	0	
METHANE	6097.866	6097.866	6081.577	6081.577	6081.577	
METHANOL	0	0	0	0	0	
ETHANE	244.332	244.332	244.351	244.351	244.351	
ETHYLENE	0	0	0	0	0	
С	0	0	0	0	0	
S	0	0	0.248	0	0	

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PENTANE         2.606         <	0 0 0 0 0 3 6 6
Mole Frac         H2O         0         0         0         0         0.056           O2         0	2
H2O0000.056O200000N20.0120.0120.0120.0120.011	
O2         0	~
N2 0.012 0.012 0.012 0.012 0.011	
NO 0 0 0 0 0	0
	0
	0
NH3 0 0 0 0 0	0
HNO3 0 0 0 0 0	0
NH4NO3 0 0 0 0 0	0
H2 0 0 0.005 0.005 0.005	5
CO 0 0.005 0.005 0.005	5
	0
	0
	0
METHANE 0.936 0.936 0.929 0.929 0.876	-
	0
ETHANE 0.037 0.037 0.037 0.037 0.035	
	0
	0
	0
	0
	0 0
	0
	0
	0
PROPANE 0.009 0.009 0.009 0.009 0.009	-
BUTANE 0.003 0.003 0.003 0.003 0.003	
	0
	0

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	NG-7	NG-8	NG-8A	NG-9	NG-10
Temperature F	662	925.1	782.6	806.8	1292
Pressure psi	350.59	350.59	347.59	347.59	344.59
Vapor Frac	1	1	1	1	1
Mole Flow Ibmol/hr	6941.555	40890.665	42398.693	42458.587	42458.587
Mass Flow Ib/hr		730631.091			
Volume Flow cuft/hr	238937.519	1.70E+06	1.59E+06	1.63E+06	2.31E+06
Enthalpy MMBtu/hr	-206.994				-3262.629
Maga Flow lb/br	NG-7	NG-8	NG-8A	NG-9	NG-10
Mass Flow lb/hr H2O	7050 160	619661 903	605079 122	589976.758	590076 759
02	20.849	20.849	20.849	20.849	20.849
N2	2172.013	2172.013	2172.013	2172.013	2172.013
AR	0	21/2.015	21/2.019	0	0
NO	0	0 0	0 0	0	0 0
NO2	0	0	0	0	0
N2O4	0	0	0	0	Ō
NH3	0.834	0.834	0.834	0.834	0.834
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	65.743	65.743	3760.277	5570.834	5570.834
СО	912.51	912.51	22032.74	230.597	230.597
CO2	0.979	0.979	0.979	35574.363	35574.363
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	97565.278	97565.278	97565.278	97084.844	97084.844
METHANOL	0	0	0	0	0
ETHANE	7347.551	7347.551	0	0	0
ETHYLENE C	0 0	0 0	0	0 0	0 0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	2643.264	2643.264	0	0	0
BUTANE	995.99	995.99	0	0	0
PENTANE	188.038	188.038	0	0	0
HEXANE	56.149	56.149	0	0	0
	NG-7	NG-8	NG-8A	NG-9	NG-10
Mass Frac		0.047			
H2O				0.807	
02	0				
N2 AR	0.018				
NO	0	0	0	0	0
	0	0	0	0	0

NUCLEAR-INTEGRATED HYDROGEN PRODUCTION ANALYSIS         Derivision: Effective Date:         10.57 (0.5/15/10)         Page: 63 of 151           NO2         0         0         0         0         0         0         0           N204         0         0         0         0         0         0         0           N204         0         0         0         0         0         0         0           NH3         0         0         0         0         0         0         0           MH4N03         0         0         0         0         0         0         0           METHANDL         0         0         0         0         0         0         0           SO2         0         0         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133         0.133           METHANE         0.62         0.01         0         0         0         0           CD2         0         0         0         0         0         0         0           LTHANE         0.622         0.01         0 <td< th=""><th colspan="2">ldaho National Laboratory</th><th>Ider</th><th>ntifier:</th><th>TEV-693</th><th></th></td<>	ldaho National Laboratory		Ider	ntifier:	TEV-693	
PRODUCTION ANALYSIS         Effective Date:         05/15/10         Page: 63 of 151           NO2         0         0         0         0         0         0           NO3         0         0         0         0         0         0           H033         0         0         0         0         0         0           M44N03         0.001         0         0.005         0.008         0.008           CO         0.008         0.001         0         0         0         0           K2         0.001         0         0         0         0         0         0           K2         0         0         0         0         0         0         0         0           K2         0         0         0         0         0         0         0         0           K2         0         0         0         0         0         0         0         0         0           K2         0         0         0         0         0         0         0         0         0           K2         0         0         0         0         0         0 <th>NUCLEAR-INTEGRAT</th> <th>ED HYDRO</th> <th></th> <th></th> <th></th> <th></th>	NUCLEAR-INTEGRAT	ED HYDRO				
NO2         0         0         0         0         0         0         0           NO2         0         0         0         0         0         0         0           NA204         0         0         0         0         0         0         0           NH3         0         0         0         0         0         0         0           NH4NO3         0         0         0         0         0         0         0           NH4NO3         0         0         0         0         0         0         0           CO         0.008         0.001         0.005         0.008         0.008         0           CO2         0         0         0         0         0         0         0           SO2         0         0         0         0         0         0         0           C         0         0         0         0         0         0         0           CP         0         0         0         0         0         0         0           C2         0         0         0         0         0	<b>PRODUCTION A</b>	NALYSIS				D (2 ) (1 )
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652			Effe	ective Date:	05/15/10	Page: 63 of 151
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652						
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652						
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652						
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652						
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652						
N204         0         0         0         0         0           NH3         0         0         0         0         0           NH4NO3         0         0         0         0         0           HN03         0         0         0         0         0           H2         0.001         0.005         0.008         0.001           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133         0.133           METHANE         0.662         0.01         0         0         0           ETHANE         0.662         0.01         0         0         0           CARB         0         0         0         0         0         0           CARB         0         0         0         0         0         0         0           ZNS         0         0         0         0         0         0         0         0           PROPANE         0.022         0.065         0.652         0.652	NO2	0	0	0	0	0
HN03       0       0       0       0       0         H2       0.001       0.005       0.008       0.008         CO       0.008       0.001       0.03       0       0         CO       0.008       0.001       0.03       0       0         CO       0       0       0       0.049       0.049         H2S       0       0       0       0       0       0         SO2       0       0       0       0       0       0         METHANE       0.82       0.134       0.133       0.133       0.133         METHANE       0.82       0.134       0.133       0.133         ETHANE       0.062       0.01       0       0       0         C       0       0       0       0       0       0         CAR       0.062       0.01       0       0       0       0         ZNO       0       0       0       0       0       0       0         ZNS       0       0       0       0       0       0       0       0         PROPANE       0.022       0.004       0						
NH4NO3         0         0         0         0         0         0           H2         0.001         0         0.005         0.008         0.001           CO         0.008         0.001         0.033         0         0           CO2         0         0         0         0.049         0.049           H2S         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133           METHANE         0.82         0.01         0         0         0           ETHANE         0.62         0.01         0         0         0           ETHANE         0.62         0.01         0         0         0           UREA         0         0         0         0         0         0           UREA         0         0         0         0         0         0         0           ZNO         0         0         0         0         0         0         0           ZNS         0         0         0         0	NH3	0	0	0	0	0
H2       0.001       0       0.005       0.008       0.008         CO       0.001       0.03       0       0       0         CO2       0       0       0       0.049       0.049         H2S       0       0       0       0       0       0         SO2       0       0       0       0       0       0         METHANE       0.82       0.134       0.133       0.133       0.133         METHANE       0.82       0.134       0.134       0.133       0.133         METHANOL       0       0       0       0       0       0         ETHANE       0.062       0.01       0       0       0       0         ETHANE       0.062       0.01       0       0       0       0         UREA       0       0       0       0       0       0       0         ZNS       0       0       0       0       0       0       0       0         PENTANE       0.002       0       0       0       0       0       0       0         PENTANE       0.022       0.004       0       0 <td>HNO3</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>	HNO3	0	0	0	0	0
CO         0.008         0.001         0.03         0         0           CO2         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133           METHANOL         0         0         0         0           ETHYLENE         0.00         0         0         0           CARB         0         0         0         0           UREA         0         0         0         0           ZNS         0         0         0         0           ZNS         0         0         0         0           QUES         0         0         0         0           PROPANE         0.022         0.004         0         0           QUES         0         0         0         0           PROPANE         0.022         0.004         0         0           QUE         0         0         0         0           NG-7         NG-8         NG-8A         NG-9         NG-10           NO2         0 <td>NH4NO3</td> <td></td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>	NH4NO3		0	0	0	0
CO2         0         0         0         0.049         0.049           H2S         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133           METHANE         0.062         0.01         0         0           ETHANE         0.062         0.01         0         0           ETHYLENE         0         0         0         0         0           CARB         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           CHAS         0.002         0         0         0         0           BUTANE         0.002         0         0         0         0           NG-7         NG-8         NG-9         NG-1         0         0           NEANE         0         0         0         0         0         0           NC47         NG-8         NG-9         NG-1         0 <td></td> <td></td> <td></td> <td></td> <td>0.008</td> <td>0.008</td>					0.008	0.008
H2S       0       0       0       0       0         SO2       0       0       0       0       0       0         METHANE       0.82       0.134       0.133       0.133         METHANOL       0       0       0       0       0         ETHANE       0.062       0.01       0       0         ETHANE       0       0       0       0         C       0       0       0       0       0         C       0       0       0       0       0         JANG       0       0       0       0       0         ZNO       0       0       0       0       0         ZNO       0       0       0       0       0         CHANS       0       0       0       0       0         ZNO       0       0       0       0       0       0         ZNO       0       0       0       0       0       0       0         BUTANE       0.022       0.04       0       0       0       0       0         PENTANE       0.022       0.652       0.652 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
SO2         0         0         0         0         0           METHANE         0.82         0.134         0.133         0.133           METHANOL         0         0         0         0           ETHANE         0.062         0.01         0         0           ETHANE         0.062         0.01         0         0           ETHANE         0         0         0         0           C         0         0         0         0           C         0         0         0         0           UREA         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0         0           C2H6S         0         0         0         0         0         0           BUTANE         0.002         0         0         0         0         0           METANE         0.022         0.052         0.652         0.652         0.652         0.652         0.652         0.652         0.652         0.652         0.652         0.652         0.652						
METHANE         0.82         0.134         0.134         0.133         0.133           METHANOL         0         0         0         0         0         0           ETHANE         0.062         0.01         0         0         0           ETHANE         0         0         0         0         0           ETHYLENE         0         0         0         0         0           C         0         0         0         0         0           UREA         0         0         0         0         0           UREA         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C4HDS         0.022         0.004         0         0         0           BUTANE         0.002         0.001         0         0         0           NG-7         NG-8         NG-9         NG-17         12748.687         32748.687         32748.687         32748.687         32748.687         12748.687         12748.687         12748.687         12748.687 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
METHANOL         0         0         0         0         0         0           ETHANE         0.062         0.01         0         0         0           CTHANE         0         0         0         0         0           C         0         0         0         0         0           C         0         0         0         0         0           UREA         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           CHHOS         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           PROPANE         0.002         0         0         0         0           METANE         0.002         0         0         0         0           NG-7         NG-8         NG-9         NG-10         0         0           ND         NG-7         NG-52         77.535         77.535         77.535         77.535           NO						
ETHANE         0.062         0.01         0         0         0           ETHYLENE         0         0         0         0         0         0           C         0         0         0         0         0         0           S         0         0         0         0         0         0           QARE         0         0         0         0         0         0           ZNO         0         0         0         0         0         0           C2H6S         0         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           BUTANE         0.002         0         0         0         0           NG-7         NG-8         NG-9         NG-1           Mole Flow Ibmol/hr         14340.954         33586.94         32748.687         32748.687           Q2         0.652         0.652         0.652         0.652         0.652         0.652           NO         0         0         0         0         0         0         0           NO         0         0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
ETHYLENE         0         0         0         0         0         0           C         0         0         0         0         0         0           S         0         0         0         0         0         0           UREA         0         0         0         0         0         0           ZNO         0         0         0         0         0         0           ZNO         0         0         0         0         0         0           C4H10S         0         0         0         0         0         0           C4H10S         0.002         0         0         0         0         0           BUTANE         0.002         0         0         0         0         0           BUTANE         0.002         0         0         0         0         0           PENPANE         0.002         0         0         0         0         0           NG-7         NG-8         NG-8A         32748.687         32748.687         32748.687           NQ2         0.652         0.652         0.652         0.652         0.652						
C         0         0         0         0         0         0           UREA         0         0         0         0         0           CARB         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C4H10S         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           BUTANE         0.002         0         0         0         0           NG-7         NG-8         NG-8         NG-9         NG-10           HEXANE         0         0         0         0         0           NO         0         0         0         0         0         0           NC-7         NG-8         NG-9         NG-9         NG-10         NG-10           NO         0         0         0         0         0         0           NO         0         0         0         0         0         0         0         0         0 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
S         0         0         0         0         0           UREA         0         0         0         0         0           CARB         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C4H10S         0         0         0         0         0           C4H10S         0.022         0.004         0         0         0           PROPANE         0.022         0.004         0         0         0           PROPANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           Mole Flow Ibmol/hr         H20         391.843         34340.954         32586.94         32748.687         32748.687           N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0           NO2         0.652         0.652         0.652         0.652         0.652 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
UREA         0         0         0         0         0           CARB         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C2H6S         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           PROPANE         0.002         0         0         0         0           BUTANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           Mole Flow Ibmol/hr         H2O         391.843         34340.954         32748.687         32748.687           N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0           NO2         0         0         0         0         0           NO2         0         0         0         0         0           NO4         0.0					-	
CARB         0         0         0         0         0           ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C2H6S         0         0         0         0         0           C4H10S         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           BUTANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           Mole Flow         bmol/hr          7         NS-8         NG-9         NG-10           H2O         391.843         34340.954         3326.954         32748.687         32748.687           Q2         0.652         0.652         77.535         77.535         77.535         77.535           AR         0         0         0         0         0         0           NO2         0         0         0         0         0         0           NA3         0.049         0.049         0.049 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
ZNO         0         0         0         0         0           ZNS         0         0         0         0         0           C2H6S         0         0         0         0         0           C4H10S         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           BUTANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           Mole Flow         bmol/hr         H20         391.843         34340.954         32748.687         32748.687           702         0.652         0.652         0.652         0.652         0.652           N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0         0           NO2         0         0         0         0         0         0         0           NQ4         0.049         0.049 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
ZNS       0       0       0       0       0         C2H6S       0       0       0       0       0         C4H10S       0       0       0       0       0         PROPANE       0.022       0.004       0       0       0         BUTANE       0.002       0       0       0       0         PENTANE       0.002       0       0       0       0         MOE       NG-N       NG-8A       NG-9       NG-10         Mole Flow Ibmol/hr       1       10       0       0       0         H2O       391.843       34340.954       33586.94       32748.687       32748.687         O2       0.652       0.652       0.652       0.652       0.652         N2       77.535       77.535       77.535       77.535       77.535         AR       0       0       0       0       0         NO2       0       0       0       0       0         NO2       0       0       0       0       0         NO2       0       0       0       0       0         NH3       0.049       0.049<						
C2H6S         0         0         0         0         0         0           C4H10S         0         0         0         0         0         0           PROPANE         0.022         0.004         0         0         0           BUTANE         0.002         0         0         0         0           PENTANE         0.002         0         0         0         0           MO         NG-7         NG-8         NG-8         NG-9         NG-10           H2O         391.843         34340.954         33586.94         32748.687         32748.687           O2         0.652         0.652         0.652         0.652         0.652           N2         77.535         77.535         77.535         77.535           AR         0         0         0         0           NO2         0         0         0         0         0           NA3         0.049         0.049         0.049         0.049         0.049           NH3         0.049         0.049         0.049         0.049         0.049           HA03         0         0         0         0         0						
C4H10S       0       0       0       0       0         PROPANE       0.022       0.004       0       0       0         BUTANE       0.002       0       0       0       0         PENTANE       0.002       0       0       0       0         PENTANE       0.002       0       0       0       0         Mole Flow       Ibmol/hr					-	
PROPANE         0.022         0.004         0         0         0           BUTANE         0.008         0.001         0         0         0           PENTANE         0.002         0         0         0         0           HEXANE         0.002         0         0         0         0           NG-7         NG-8         NG-8A         NG-9         NG-10           Mole Flow Ibmol/hr         1 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
BUTANE         0.008         0.001         0         0         0           PENTANE         0.002         0         0         0         0           NG-N         NG-N         NG-N         NG-N         NG-N           NG-N         NG-N         NG-N         NG-N         NG-N           Mole Flow Ibmol/hr         391.843         34340.954         33586.94         32748.687         32748.687           O2         0.652         0.652         0.652         0.652         0.652         0.652           N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0           NO2         0         0         0         0         0           N2G4         0         0         0         0         0           NA3         0.049         0.049         0.049         0.049         0.049           NH4NO3         0         0         0         0         0         0           H2         32.612         32.578         786.591         8.233         8.233           CO         0         0         0         0						
PENTANE         0.002         0         0         0         0           NG-7         NG-8         NG-8A         NG-9         NG-10           Mole Flow Ibmol/hr          33586.94         32748.687         32748.687           H2O         391.843         34340.954         33586.94         32748.687         32748.687           O2         0.652         0.652         0.652         0.652         0.652           N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0           NO2         0         0         0         0         0           NQ4         0         0         0         0         0           NQ2         0         0         0         0         0           NQ4         0.049         0.049         0.049         0.049         0.049           NH3         0.049         0.049         0.049         0.049         0         0         0         0           NH4NO3         0         0         0         0         0         0         0         0         0         0						
HEXANE00000NG-7NG-8NG-8NG-9NG-10Mole Flow Ibmol/hr391.8434340.9543358.6932748.68732748.687H2O391.8520.6520.6520.6520.552O20.6520.6520.6520.5520.552N277.53577.53577.53577.53577.535AR00000NO200000NO200000ND440.0490.0490.0490.049HN030.0490.0490.0490.049HN0300000H232.61232.6121865.3282763.475CO32.57832.578786.5918.2338.233CO20.0220.020.022808.328H2S00000SO200000KETHANE6081.5776081.5776051.636051.63METHANOL00000ETHYLENE00000C00000NG-N00000NG-N00000HNO300000CO00000HNO30000 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
NG-7         NG-8         NG-8A         NG-9         NG-10           H2O         391.843         34340.954         33586.94         32748.687         32748.687           O2         0.652         0.652         0.652         0.652         0.652         0.652           N2         77.535         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0         0           NO2         0         0         0         0         0         0           NC24         0         0         0         0         0         0           NH3         0.049         0.049         0.049         0.049         0.049           HNO3         0         0         0         0         0           H2         32.612         32.612         1865.328         2763.475         2763.475           CO         32.578         32.578         786.591         8.233         8.233           CO2         0.022         0.022         0.022         808.328         808.328           H2S         0         0         0         0         0         0						
Mole Flow Ibmol/hrH2O391.84334340.95433586.9432748.68732748.687O20.6520.6520.6520.6520.652N277.53577.53577.53577.535AR00000NO00000NO00000NO00000NO00000NO200000ND490.0490.0490.0490.049NH30.0490.0490.0490.049NH30.0490.0490.0490.049HNO300000H232.61232.6121865.3282763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776081.5776051.636051.63METHANOL000000ETHANE244.351244.351000CO000000METHANE000000CO000000METHANE244.351244.3510 </td <td></td> <td></td> <td>-</td> <td>-</td> <td>-</td> <td></td>			-	-	-	
H2O391.84334340.95433586.9432748.68732748.687O20.6520.6520.6520.6520.652N277.53577.53577.53577.535AR00000NO00000NO200000N20400000NH30.0490.0490.0490.049HNO300000H232.61232.6121865.3282763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.0220.022808.328H2S000000METHANE6081.5776081.5776081.5776051.636051.63METHANOL000000ETHANE244.351244.351000C000000	Mole Flow Ibmol/hr					
O20.6520.6520.6520.6520.6520.652N277.53577.53577.53577.53577.535AR00000NO00000NO200000N20400000NH30.0490.0490.0490.049HN0300000H232.61232.6121865.3282763.475CO32.57832.578786.5918.2338.233CO200000SO200000METHANE6081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000CO00000O00000O00000O00000O00000CO00000O00000O00000O00000O00000O00000O00000		391.843	34340.954	33586.94	32748.687	32748.687
N2         77.535         77.535         77.535         77.535         77.535           AR         0         0         0         0         0         0           NO         0         0         0         0         0         0           NO         0         0         0         0         0         0           NO2         0         0         0         0         0         0           N2O4         0         0         0         0         0         0           NH3         0.049         0.049         0.049         0.049         0.049           HNO3         0         0         0         0         0         0           NH4NO3         0         0         0         0         0         0           H2         32.612         32.612         1865.328         2763.475         2763.475           CO2         32.578         32.578         786.591         8.233         8.233           CO2         0.022         0.022         808.328         808.328         1425         0         0         0         0         0         0         0         0         0		0.652				
NO00000NO200000N2O400000NH30.0490.0490.0490.049HNO300000NH4NO300000H232.61232.6121865.3282763.4752763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776051.636051.63METHANE244.351244.351000ETHANE00000C00000						
NO00000NO200000N2O400000NH30.0490.0490.0490.049HNO300000NH4NO300000H232.61232.6121865.3282763.4752763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776051.636051.63METHANE244.351244.351000ETHANE00000C00000	AR	0	0	0	0	0
N20400000NH30.0490.0490.0490.0490.049HN0300000NH4N0300000H232.61232.6121865.3282763.4752763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776081.5776051.636051.63METHANE244.351244.351000ETHYLENE00000C000000			0	0	0	0
NH30.0490.0490.0490.0490.049HN0300000NH4N0300000H232.61232.6121865.3282763.4752763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000C000000	NO2	0	0	0	0	0
HNO300000NH4NO300000H232.61232.6121865.3282763.4752763.475CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000C000000	N2O4	0	0	0	0	0
NH4NO3         0         0         0         0         0           H2         32.612         32.612         1865.328         2763.475         2763.475           CO         32.578         32.578         786.591         8.233         8.233           CO2         0.022         0.022         0.022         808.328         808.328           H2S         0         0         0         0         0           SO2         0         0         0         0         0           METHANE         6081.577         6081.577         6051.63         6051.63           METHANE         244.351         244.351         0         0         0           ETHYLENE         0         0         0         0         0         0           CTHANE         244.351         244.351         0         0         0         0           C         0         0         0         0         0         0         0	NH3	0.049	0.049	0.049	0.049	0.049
H2       32.612       32.612       1865.328       2763.475       2763.475         CO       32.578       32.578       786.591       8.233       8.233         CO2       0.022       0.022       0.022       808.328       808.328         H2S       0       0       0       0       0         SO2       0       0       0       0       0         METHANE       6081.577       6081.577       6081.577       6051.63       6051.63         METHANE       244.351       244.351       0       0       0       0         ETHYLENE       0       0       0       0       0       0         C       0       0       0       0       0       0						
CO32.57832.578786.5918.2338.233CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776081.5776051.636051.63METHANE244.351244.351000ETHYLENE00000C00000		-	-	-	-	-
CO20.0220.0220.022808.328808.328H2S00000SO200000METHANE6081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000ETHYLENE00000C00000						
H2S00000SO200000METHANE6081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000ETHYLENE00000C00000						
SO2         0         0         0         0         0           METHANE         6081.577         6081.577         6081.577         6051.63         6051.63           METHANOL         0         0         0         0         0         0           ETHANE         244.351         244.351         0         0         0         0           ETHYLENE         0         0         0         0         0         0         0           C         0         0         0         0         0         0         0						
METHANE6081.5776081.5776051.636051.63METHANOL00000ETHANE244.351244.351000ETHYLENE00000C00000						
METHANOL         0<		-	-	-	-	
ETHANE244.351244.351000ETHYLENE00000C00000						
ETHYLENE         0<		-				
C 0 0 0 0 0						
				-	-	
5 0 0 0 0					-	
	5	0	0	0	0	U

PENTANE

HEXANE

Idaho National Laboratory					
		Ident	tifier:	TEV-693	
NUCLEAR-INTEGRATI PRODUCTION A		Revi	sion:	1	
<b>PRODUCTION A</b>	NAL Y 515	Effe	ctive Date:	05/15/10	Page: 64 of 151
I					
UREA	0	0	0	0	0
CARB	0	0	0		0
ZNO	0	0	0		0
ZNO	0	0	0		0
C2H6S	0	0	0		0
C4H10S	0	0	0		0
PROPANE	59.943	59.943	0		
BUTANE	17.136	17.136	0	-	0 0
PENTANE	2.606 0.652	2.606	0	-	0 0
HEXANE	0.652 NG-7 NG-8	0.652	U NG-8A	0 NG-9	0 NG-10
Mole Frac	NG-7 NG-8		NG-8A	NG-9	NG-10
H2O	0.056	0.84	0.792	0.771	0.771
02	0.058	0.84	0.792		0.771
N2	0.011		0.002		0.002
AR		0.002			0.002
NO	0	0	0		
NO2	0 0	0	0 0		0 0
		0			
N2O4	0	0	0		0
NH3	0	0	0	-	0
HNO3	0	0	0	-	0
NH4NO3	0	0	0	-	0
H2	0.005	0.001	0.044		0.065
CO	0.005	0.001	0.019		0
CO2	0	0	0		0.019
H2S	0	0	0	-	0
SO2	0	0	0	-	0
METHANE	0.876	0.149	0.143		0.143
METHANOL	0	0	0		0
ETHANE	0.035	0.006	0		0
ETHYLENE	0	0	0		0
С	0	0	0	-	0
S	0	0	0		0
UREA	0	0	0		0
CARB	0	0	0		0
ZNO	0	0	0		0
ZNS	0	0	0		0
C2H6S	0	0	0		0
C4H10S	0	0	0		0
PROPANE	0.009	0.001	0		0
BUTANE	0.002	0	0	0	0

NUCLEAD INTECDATED HVDDOCEN	Identifier:	TEV-693	
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	NG-BURN	S-CAPTUR	SG-1	SG-OUT	STEAM
Temperature F	94.2	70	1598	700	485.2
Pressure psi	362.59		341.59	338.59	600
Vapor Frac	1		1	1	1
Mole Flow Ibmol/hr Mass Flow Ib/hr	3291.881 56560.682		53812.435	53812.435 730631.091	33949.11
Volume Flow cuft/hr	51185.799		3.49E+06		486069.137
Enthalpy MMBtu/hr	-107.195				
	NG-BURN			SG-OUT	STEAM
Mass Flow lb/hr					
H2O	0	0	446631.689	446631.689	611602.723
02	10.531	0	0	0	0
N2	1097.122		2129.142	2129.142	0
AR	0		0	0	0
NO NO2	0 0		0	0	0
N2O4	0	0	0	0	0 0
NH3	0	0	52.96	52.96	0
HNO3	0	0	0	0	0 0
NH4NO3	0	0	0	0	0
H2	0	0	44497.141	44497.141	0
СО	0	0	95449.064	95449.064	0
CO2	362.101	0	135889.567	135889.567	0
H2S	0.561	0	0	0	0
SO2	0	-	0	0	0
METHANE	49413.914 0	0	5981.418 0	5981.418	0
METHANOL ETHANE	0 3711.079	0	0.11	0 0.11	0 0
ETHYLENE	0		0.11	0.11	0
C	0	0	0	0	0
S	0		0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S C4H10S	0.613	0 0	0 0	0 0	0
PROPANE	8.905 1335.159	0	0	0	0 0
BUTANE	497.353	0	0	0	0
PENTANE	94.981	0	0	0	0
HEXANE	28.362	0	0	0	0
	NG-BURN	S-CAPTUR	SG-1	SG-OUT	STEAM
Mass Frac					
H2O	0		0.611		1
02	0	-	0		0
N2	0.019		0.003	0.003	0
AR NO	0 0		0	0	0 0
	0	0	0	0	0

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE	0 0 0 0.01 0.099 30.278	0 0 0 0 0 0 0 0 0	0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
BUTANE	8.557	0		0	0
PENTANE	1.316	0	0	0	0
HEXANE	0.329	0	0	0	0
	NG-BURN	S-CAPTUR	SG-1	SG-OUT	STEAM
Mole Frac					
H2O	0	0	0.461	0.461	1
02	0	0			0
N2	0.012	0		0.001	0
AR	0	0	-	-	0
NO	0	0		0	0
NO2	0	0		0	0
N2O4	0	0		0	0
NH3	0	0		0	0
HNO3	0	0		0	0
NH4NO3	0	0		0	0
H2	0	0		0.41	0
CO	0	0			0
CO2	0.002	0		0.057	0
H2S	0	0	-		0
SO2	0	0	-	-	0
METHANE	0.936	0		0.007	0
METHANOL	0	0			0
ETHANE ETHYLENE	0.037	0 0		0	0 0
C	0 0	0		0 0	0
S	0	1	0		0
S UREA	0	0			0
CARB	0	0		0	0
ZNO	0	0		0	0
ZNS	0	0	-	0	0
C2H6S	0	0		0	0
C4H10S	0	0		0	0
PROPANE	0.009	0		0	0
BUTANE	0.003	0			0
PENTANE	0.005	0	0	0	0
HEXANE	0	0	0	0	0
	Ŭ	0	0	0	Ŭ

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	STM-SH	WATER-IN
Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	1022 600 1 33949.11 611602.723 873043.482 -3268.49 STM-SH	104.6 600 0 391.917 7060.989 134.733 -48.254 WATER-IN
Mass Flow lb/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANOL ETHANE ETHYLENE C S SO2 METHANE ETHYLENE C S SO2 METHANE METHANOL ETHANE ETHYLENE C S S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE BUTANE PENTANE HEXANE	611602.723 0 0 0 0 0 0 0 0 0 0 0 0 0	7059.169 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mass Frac H2O O2	STM-SH	WATER-IN 1 0
N2 AR NO	0 0 0	0 0 0

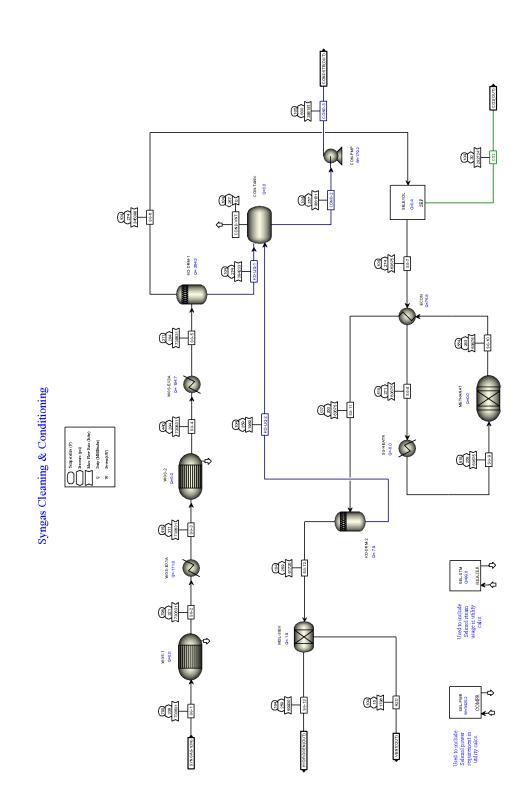
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NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANOL ETHANE ETHYLENE C S UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE		
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANE ETHYLENE C S	STM-SH 33949.11 0 0 0 0 0 0 0 0 0 0 0 0 0	WATER-IN 391.843 0 0 0 0 0 0 0 0 0 0 0 0 0

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE		0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	STM-SH	WATER	-IN
Mole Frac H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE ETHYLENE C S UREA CARB ZNO ZNS	STM-SH	WATER  1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	-IN 1 0 0 0 0 0 0 0 0 0 0 0 0 0
C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE		0 0 0 0 0	0 0 0 0 0

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	CO2	COND-2	COND-3	COND-VNT	H2O
Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	104 30 1 6466.603 282723.87 1.29E+06 -1085.797 CO2	257.29 0 21434.816 386181.143 7369.579	7368.831	257.29 1 0.013 0.146 0.309	34.276 -12.278
Mass Flow lb/hr H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE ETHANE ETHYLENE METHANOL C	0 0 0 81.988 17.23 282531.577 0 0 59.813 0.001 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0.002 0 45.596 0.257 0.002 53.548 0 0 0.091 0 0 0 0 0 0 0 0	386081.646 0 0.002 0 45.596 0.257 0.002 53.548 0 0 0 0.091 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0.001 0 0 0.021 0.001 0.121 0 0 0.003 0 0.003 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
S	0 CO2	0 COND-2	0 COND-3	0 COND-VNT	0 H2O
Mass Frac H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE ETHANE ETHYLENE METHANOL C S	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0.005 0 0 0 0.14 0.004 0.827 0 0 0.017 0 0 0.017 0 0 0.017 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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	CO2	COND-2	COND-3	COND-VNT	H2O
Mole Flow Ibmol/hr				-	
H2O	1.846	21430.788	21430.788	0	99.68
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0 0	-	0	0 0	0
NH3	-	2.677	2.677	-	0
H2 CO	40.671	0.128	0.128	0.01	0
CO CO2	0.615 6419.742	0 1.217	0 1.217	0	0
				0.003	0
H2S SO2	0 0	0 0	0 0	0 0	0 0
METHANE	3.728		0.006	0	0
ETHANE	0.728	0.006 0	0.008	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
5	CO2	COND-2	COND-3	COND-VNT	-
Mole Frac	602		COND		1120
H2O	0	1	1	0.004	1
02	0	0	- 0	0	0
N2	0	0	0	0.002	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0.006	0	0	0.772	0
CO	0	0	0	0.002	0
CO2	0.993	0	0	0.209	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0.001	0	0	0.012	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
MWMX	43.721	18.017	18.017	11.101	18.015

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	KO-LIQ-1	KO-LIQ-2	SG-1	SG-2	SG-3
Temperature F Pressure psi	104 274.29				415 311.44
Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	0 21326.664 384232.688 7332.154 -2626.39 KO-LIQ-1	0 108.165 1948.602 37.185	1 53812.435 730631.091 1.96E+06 -3018.264	1 53812.435 730631.091 2.25E+06 -3018.252	1 53812.435 730631.091 1.59E+06
Mass Flow lb/hr					
H2O				398314.618	-
O2 N2	0 0.003	0	-	0 2129.142	0 2129.142
AR	0.005			0	0
NO	0	0		0	0
NO2	0	0	0	0	0
NH3	45.596			52.96	52.96
H2	0.276				49903.741
CO	0.003	0			20325.032
CO2	53.67	0			253924.071
H2S SO2	0 0			0 0	0 0
METHANE	0.093				5981.418
ETHANE	0.055			0.11	0.11
ETHYLENE	0	0		0	0
METHANOL	0	0		0	0
С	0	0	0	0	0
S	0	0	0	0	0
	KO-LIQ-1	KO-LIQ-2	SG-1	SG-2	SG-3
Mass Frac					
H2O	1	1		0.545	0.545
02	0	0		0	0
N2 AR	0 0	0		0.003 0	0.003 0
NO	0	0	0	0	0
NO2	0	0		0	0
NH3	0	0		0	0
H2	0	0	0.061	0.068	0.068
СО	0	0	0.131	0.028	0.028
CO2	0	0	0.186	0.348	0.348
H2S	0	0	0	0	0
502	0	0		0	0
METHANE	0	0		0.008	0.008
	0	0	0	0	0
ETHYLENE METHANOL	0 0	0 0	0	0 0	0 0
C	0	0	0	0	0
S	0	0		0	0
-	0	0	0	0	0

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	KO-LIQ-1	KO-LIQ-2	SG-1	SG-2	SG-3
Mole Flow Ibmol/hr	21222 624	100 101	24701 026	22100.021	22100.021
H2O	21322.624			22109.821	22109.821
02	0 0	0 0	-	0 76.004	0
N2 AR	0	0		76.004	76.004 0
NO	0	0	-	0	0
NO2	0	0	-	0	0
NH3	2.677	0		3.11	3.11
H2	0.137	-		24755.313	24755.313
CO	0.1157	0.001		725.624	725.624
CO2	1.219	0		5769.717	5769.717
H2S	0	0		0	0
S02	0	0		0	0
METHANE	0.006	0	372.842	372.842	372.842
ETHANE	0	0	0.004	0.004	0.004
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
	KO-LIQ-1	KO-LIQ-2	SG-1	SG-2	SG-3
Mole Frac					
H2O	1	1		0.411	0.411
02	0	0		0	0
N2	0	0		0.001	0.001
AR	0	0	-	0	0
NO	0	0	-	0	0
NO2	0	0		0	0
NH3	0	0		0	0
H2	0	0		0.46	0.46
CO	0	0		0.013	0.013
CO2	0 0	0		0.107	0.107
H2S SO2	0	0		0	0
METHANE	0	0		0 0.007	0 0.007
ETHANE	0	0		0.007	0.007
ETHYLENE	0	0		0	0
METHANOL	0	0		0	0
C	0	0	-	0	0
S	0	0	-	0	0
мумх	18.017	18.015	-	13.577	13.577

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	SG-4	SG-5	SG-6	SG-7	SG-8
Temperature F Pressure psi	440.3 294.29	284.29	274.29	274.29	518 271.29
Vapor Frac Mole Flow Ibmol/hr	1 53812.435				1 26019.168
Mole Flow Ibmol/hr Mass Flow Ib/hr		53812.435 730631.093			63674.534
Volume Flow cuft/hr	1.74E+06			576440.124	1.01E+06
Enthalpy MMBtu/hr	-3188.921				50.405
	SG-4	SG-5	SG-6		SG-8
Mass Flow lb/hr					
H2O	386350.481	386350.481	2217.434	2184.173	2184.173
02	0				0
N2	2129.142				2129.138
AR	0				0
NO	0				0
NO2 NH3	0 52.96			-	0 7.364
H2	51242.508				51160.244
CO	1723.032				1705.799
CO2	283151.442				566.196
H2S	0		0		0
S02	0	0	0	0	0
METHANE	5981.418	5981.418	5981.325	5921.512	5921.512
ETHANE	0.11	0.11	0.11	0.109	0.109
ETHYLENE	0			-	0
METHANOL	0				0
C	0			-	0
S	0 SG-4	0 SG-5	0 SG-6	0 SG-7	0 SG-8
Mass Frac	56-4	36-3	36-0	36-7	30-0
H2O	0.529	0.529	0.006	0.034	0.034
02	0.010				0
N2	0.003	0.003	0.006	0.033	0.033
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0		0		0
NH3	0		0	-	0
H2	0.07				0.803
CO CO2	0.002 0.388		0.005 0.817		0.027 0.009
H2S	0.388				0.009
S02	0				0
METHANE	0.008				0.093
ETHANE	0				0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
C	0				0
S	0	0	0	0	0

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	SG-4	SG-5	SG-6	SG-7	SG-8
Mole Flow Ibmol/hr					
H2O	21445.711				121.24
02	0 76.004	0			0
N2 AR	76.004	76.004			76.004 0
NO	0	0 0		-	0
NO2	0	0		-	0
NH3	3.11	3.11	-		0.432
H2	25419.424	25419.424			25378.616
CO	61.514				60.899
CO2	6433.827				12.865
H2S	0155162)	0 100102/			0
S02	0	0			0 0
METHANE	372.842				369.108
ETHANE	0.004	0.004			0.004
ETHYLENE	0	0			0
METHANOL	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
	SG-4	SG-5	SG-6	SG-7	SG-8
Mole Frac					
H2O	0.399	0.399	0.004	0.005	0.005
02	0	0			0
N2	0.001	0.001	0.002	0.003	0.003
AR	0	0	-	-	0
NO	0	0	0	-	0
NO2	0	0	0		0
NH3	0	0	0		0
H2	0.472	0.472			0.975
CO	0.001	0.001			0.002
CO2	0.12	0.12			0
H2S	0	0			0
S02	0	0	-	-	0
METHANE	0.007	0.007			0.014
ETHANE	0	0		-	0
ETHYLENE	0	0	0		0
METHANOL	0	0	0	-	0
C S	0	0 0	0 0	-	0 0
S MWMX	0 13.577	0 13.577	0 10.663	-	0 2.447
INIVINA	13.5//	13.5//	10.003	2.447	2.447

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	SG-9	SG-10	SG-11	SG-12	SG-13
Temperature F	518	554	136.8	104	104
Pressure psi	268.29			259.29	259.29
Vapor Frac	1	1	1	1	1
Mole Flow Ibmol/hr	26019.168	25872.072	25872.072	25763.908	25664.228
Mass Flow lb/hr	63674.534	63674.534		61725.932	
Volume Flow cuft/hr	1.02E+06		639494.424		601993.862
Enthalpy MMBtu/hr	50.404			-19.966	-9.599
	SG-9	SG-10	SG-11	SG-12	SG-13
Mass Flow lb/hr	2104 172	2744 022	2744 022	1706 222	0.460
H2O O2	2184.173			1796.222	0.462
N2	0 2129.138	-	-	0 2135.195	0 2135.195
AR	2129.138			2155.195	2155.195
NO	0		-	0 0	0
NO2	0		0	0	0
NH3	7.364		0	0	0
H2	51160.244	50689.512	50689.512	50689.51	50689.51
CO	1705.799	0	0	0	0
CO2	566.196	0		0	0
H2S	0			0	0
SO2	0		•	0	0
METHANE	5921.512			7105.005	7105.005
ETHANE	0.109			0	0
ETHYLENE METHANOL	0 0		-	0	0 0
C	0			0	0
S	0	-	-	0	0
2	SG-9	SG-10	SG-11	SG-12	SG-13
Mass Frac					
H2O	0.034	0.059	0.059	0.029	0
02	0	0	0	0	0
N2	0.033	0.034	0.034	0.035	0.036
AR	0			0	0
NO	0			0	0
NO2	0			0	0
NH3 H2	0 0.803	0 0.796	-	0	0
CO	0.803		0.796 0	0.821 0	0.846 0
CO2	0.027	0	0	0	0
H2S	0.009	0	0	0	0
S02	0	-	-	0	0
METHANE	0.093			0.115	0.119
ETHANE	0			0	0
ETHYLENE	0	0	0	0	0
METHANOL	0			0	0
С	0			0	0
S	0	0	0	0	0

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Mole Flow Ibmol/hr	SG-9	SG-10	SG-11	SG-12	SG-13
H2O	121.24	207.869	207.869	99.705	0.026
02	0	0	0	0	0
N2	76.004	76.22	76.22	76.22	76.22
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0.432	0	0	0	0
H2	25378.616	25145.104	25145.104	25145.103	25145.103
СО	60.899	0	0	0	0
CO2	12.865	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	369.108	442.879	442.879	442.879	442.879
ETHANE	0.004	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
	SG-9	SG-10	SG-11	SG-12	SG-13
Mole Frac					
H2O	0.005	0.008		0.004	0
02	0	0	-	0	0
N2	0.003	0.003		0.003	0.003
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0.975	0.972	0.972	0.976	0.98
CO	0.002	0		0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0.014	0.017	0.017	0.017	0.017
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
C S	0	0	0	0	0
	-	•	-	-	0
MWMX	2.447	2.461	2.461	2.396	2.335

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## WGS-LIQ1 WGS-LIQ2 ZZDUMMY3 ZZDUMMY4 ZZDUMMY5

Temperature F			77	128.6	212
Pressure psi	321.44	294.29	1	1.26	14.7
Vapor Frac	0	0	1	1	0
Mole Flow Ibmol/hr	0		32485.771	32485.771	32485.771
Mass Flow lb/hr	0	-		910039.499 1.62E+08	
Volume Flow cuft/hr	0	0	1.87E+08		9781.653
Enthalpy MMBtu/hr			-0.007	11.663	-3915.332
Mass Flow lb/hr	WGS-LIQI	WGS-LIQZ		ZZDUMMY4	
H2O	0	0	0	0	585240.263
02	0		0	0	0 Joseph 203
N2	0		-	910039.499	0
AR	0	0	910039.499 0	910039.499	0
NO	0		0	0	0
NO2	0		0	0	0
NH3	0		0	0	0
H2	0		0	0	0
CO	0		0	0	0
CO2	0	-	0	0	Ő
H2S	0		0	0	0
S02	0		0	0	0
METHANE	0	0	0	0	0
ETHANE	0		0	0	0
ETHYLENE	0		0	0	0
METHANOL	0		0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
	WGS-LIO1	WGS-LIO2	ZZDUMMY3	ZZDUMMY4	ZZDUMMY5
Mass Frac	c	Ľ			
H2O			0	0	1
02			0	0	0
N2			1	1	0
AR			0	0	0
NO			0	0	0
NO2			0	0	0
NH3			0	0	0
H2			0	0	0
СО			0	0	0
CO2			0	0	0
H2S			0	0	0
S02			0	0	0
METHANE			0	0	0
ETHANE			0	0	0
ETHYLENE			0	0	0
METHANOL			0	0	0
C			0	0	0
S			0	0	0

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Mole Flow Ibmol/hr	WGS-LIQ1	WGS-LIQ2	ZZDUMMY3	ZZDUMMY4	ZZDUMMY5
H2O	0	0	0	0	32485.771
02	0	0		0	0
N2	0	0		32485.771	0
AR	0	0	0		0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0		0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
	WGS-LIQ1	WGS-LIQ2	ZZDUMMY3	ZZDUMMY4	ZZDUMMY5
Mole Frac	0	0	0	0	4
H2O O2	0 0	0	0 0	0 0	1 0
N2	0	0	1	1	0
AR	0	0	0	0	0
NO	0	0	0	-	0
NO2	0	0	0		0
NH3	0	0	0	-	0
H2	0	0	0	0	0
CO	0	0	0		0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	-	0	-	0
С	0	0	0	0	0
S	0	0	0	0	0
MWMX			28.013	28.013	18.015

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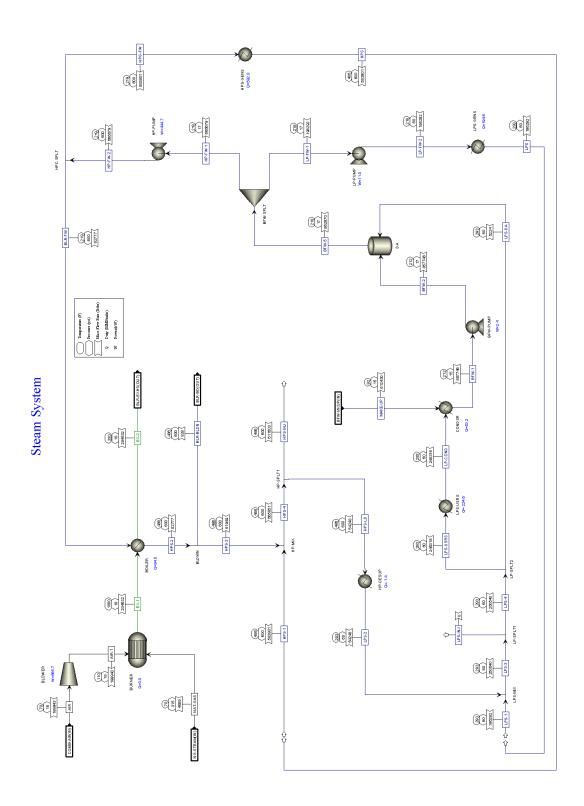
## ZZDUMMY6

Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	212 14.7 0.174 32485.771 585240.263 2.74E+06 -3816.347 ZZDUMMY6
Mass Flow Ib/hr H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE ETHANE ETHANE ETHYLENE METHANOL C S	585240.263 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mass Frac H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE ETHANE ETHYLENE METHANOL C S	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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Mala Flaw, Jhra	ZZDUMMY6
Mole Flow Ibmo H2O O2 N2 AR NO NO2 NH3	ol/hr 32485.771 0 0 0 0 0 0
H2 CO CO2 H2S SO2	0 0 0 0
METHANE ETHANE ETHYLENE METHANOL	0 0 0 0 0
C S	0 0 ZZDUMMY6
Mole Frac H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE ETHANE ETHYLENE METHANOL C	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
S MWMX	0 18.015

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	AIR	AIR-1	BFW-1	BFW-2	BFW-5
Temperature F Pressure psi Vapor Frac	70 14.7 1		212 14.7 0	212 17.19 0	218 17.19 0
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr	6928.996		47612.154 857746.286	47612.154 857746.286	47902.126
Enthalpy MMBtu/hr	-7.85 AIR				-5768.16 BFW-5
Mass Flow lb/hr H2O	1235.919	1235.919	857746.286	857746.286	
O2 N2	46078.155		0	0	0
AR NO	2576.154	2576.154	0	0	0
NO2	0	0	0	0	0
NH3 H2	0 1.383	0 1.383	0	0	0
CO CO2	0 90.577	0 90.577	0	0	0 0
H2S SO2	0	0	0	0	0
METHANE METHANOL	0	0	0	0	0
ETHANE ETHYLENE	0	0	0	0	0
C S	0	0	0	0	0 0
Mass Frac	AIR	AIR-1	BFW-1	BFW-2	BFW-5
H2O O2	0.006 0.23	0.006 0.23	1 0	1 0	1 0
N2 AR	0.75 0.013	0.75 0.013	0 0	0 0	0 0
NO NO2	0 0	0 0	0 0	0 0	0 0
NH3 H2	0 0	0 0	0 0	0 0	0 0
CO CO2	0 0	0 0	0 0	0 0	0 0
H2S SO2	0 0	0 0	0 0	0 0	0 0
METHANE METHANOL	0 0	0 0	0 0	0 0	0 0
ETHANE ETHYLENE	0	0	0	0	0
C S	0 0	0 0	0 0	0 0	0 0

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	AIR	AIR-1	BFW-1	BFW-2	BFW-5
Mole Flow Ibmol/hr					
H2O	68.604				47902.126
02	1439.996				0
N2	5353.164				0
AR	64.488			-	0
NO	0				0
NO2	0				0
NH3	0	-	-	-	0
H2	0.686				0
CO	0				0
CO2	2.058			-	0
H2S	0				0
S02	0				0
METHANE	0	-		-	0
METHANOL	0				0
ETHANE	0				0
ETHYLENE	0				0
С	0				0
S	0	-	-	-	0
	AIR	AIR-1	BFW-1	BFW-2	BFW-5
Mole Frac					
H2O	0.01				1
02	0.208				0
N2	0.773				0
AR	0.009			-	0
NO	0				0
NO2	0				0
NH3	0				0
H2	0			-	0
CO	0				0
CO2	0				0
H2S	0				0
S02	0				0
METHANE	0				0
METHANOL	0	-		-	0
ETHANE	0				0
ETHYLENE	0				0
С	0	-		-	0
S	0			-	0
MWMX	28.856	28.856	18.015	18.015	18.015

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	BLR-BLDN	BLR-FW	EX-1	EX-2	HP-FW-1
Temperature F	486.3	219	1800	330.4	218
Pressure psi	600	600	17.7	17.7	17.19
Vapor Frac	1	0	1	1	0
Mole Flow Ibmol/hr	45.948	4594.832	7204.534	7204.534	37006.284
Mass Flow lb/hr	827.772	82777.188	204531.946	204531.946	666678.575
Volume Flow cuft/hr	637.439	1384.853	9.88E+06	3.45E+06	11170.931
Enthalpy MMBtu/hr	-4.691		-14.671	-98.709	-4456.131
	BLR-BLDN	BLR-FW	EX-1	EX-2	HP-FW-1
Mass Flow lb/hr					
H2O	827.772	82777.188			666678.575
02	0	0			0
N2	0			150049.771	0
AR	0			2576.154	0
NO	0	0	0		0
NO2	0	0	0	0	0
NH3	0			0	0
H2	0			0	0
CO	0	0		0	0
CO2	0				0
H2S	0			0	0
S02	0			0.65	0
METHANE	0			0	0
METHANOL	0		0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0			0	0
С	0	0	0	0	0
S		0	0	0	0
	BLR-BLDN	BLK-FW	EX-1	EX-2	HP-FW-1
Mass Frac H2O	1	4	0.054	0.054	1
02	1 0				1 0
N2	0			0.139	0
AR	0			0.013	0
NO	0			0.019	0
NO2	0		0	0	0
NH3	0	0	0	0	0
H2	0			0	0
СО	0	0	0	0	0
CO2	0	0	0.061	0.061	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0

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	BLR-BLDN	BLR-FW	EX-1	EX-2	HP-FW-1
Mole Flow Ibmol/hr					
H2O	45.948		613.307	613.307	37006.284
02	0	0	886.856	886.856	0
N2	0	0	5356.342	5356.342	0
AR	0	0	64.488	64.488	0
NO	0	-	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	-		283.531	0
H2S SO2	0 0	0	0 0.01	0 0.01	0
		0			0
METHANE METHANOL	0	0	0 0	0 0	0 0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
3	BLR-BLDN	-	EX-1	EX-2	HP-FW-1
Mole Frac	DEIX-DEDIX				
H2O	1	1	0.085	0.085	1
02	0	0	0.123	0.123	0
N2	0	0	0.743	0.743	0
AR	0	0	0.009	0.009	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0.039	0.039	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
MWMX	18.015	18.015	28.389	28.389	18.015

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	HP-FW-2	HPG-FW	HPS	HPS-1	HPS-2
Temperature F Pressure psi Vapor Frac	219 600 0	219 600 0	600	486.3 600 1	486.3 600 1
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	37006.284	32411.452 583901.387	32411.452 583901.387 449643.823	32411.452 583901.387 449645.054 -3308.714	4594.832 82777.188
Mass Flow lb/hr		502001 207	502001 207	500001 007	00777 100
H2O O2	666678.575 0	583901.387		583901.387 0	82777.188 0
N2	0	0		0	Ő
AR	0	0		0	0
NO	0	0	0	0	0
NO2 NH3	0 0	0 0	0 0	0 0	0 0
H2	0	0		0	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S SO2	0 0	0 0	0	0 0	0 0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0		0	0
C S	0 0	0 0	0	0 0	0 0
5	HP-FW-2	HPG-FW	HPS		HPS-2
Mass Frac					
H2O	1	1		1	1
02 N2	0	0		0	0
N2 AR	0 0	0 0	0	0 0	0 0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2 CO	0 0	0		0	0
CO2	0	0 0	0	0 0	0 0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL ETHANE	0 0	0 0	0 0	0 0	0 0
ETHYLENE	0	0	0	0	0
C	0	0		0	0
S	0	0	0	0	0

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	HP-FW-2	HPG-FW	HPS	HPS-1	HPS-2
Mole Flow Ibmol/hr					
H2O	37006.284	32411.452	32411.452	32411.452	4594.832
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
	HP-FW-2	HPG-FW	HPS	HPS-1	HPS-2
Mole Frac					
H2O	1	1	1	1	1
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
MWMX	18.015	18.015	18.015	18.015	18.015
ET WEIN	10.015	10.015	10.015	10.015	10.013

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	HPS-3	HPS-4	HPS-INJ	HPS-LD	LP-COND
Temperature F Pressure psi Vapor Frac	486.3 600 1	600		600	292.7 60 0
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr		665850.803 512750.453	611602.723	54248.08 41774.715	13617.096 245315.79 4262.938 -1621.042 LP-COND
Mass Flow Ib/hr					
H2O O2 N2	81949.417 0 0	0	611602.723 0 0	0	245315.79 0 0
AR	0	0	0	0	0
NO NO2	0 0	0 0	0 0	0	0 0
NH3 H2	0 0		0 0		0 0
CO CO2	0	0 0	0 0	0	0
H2S	0 0	0	0	0	0 0
SO2 METHANE	0 0	0 0	0 0		0 0
METHANOL ETHANE	0 0	0 0	0 0		0 0
ETHYLENE	0	0	0	0	0
C S	0 0	0 0	0 0		0 0
Mass Frac	HPS-3	HPS-4	HPS-INJ	HPS-LD	LP-COND
H2O	1	1	1		1
O2 N2	0 0	0 0	0 0		0 0
AR	0		0		0
NO NO2	0 0	0 0	0 0		0 0
NH3 H2	0 0	0 0	0 0		0 0
CO	0	0	0	0	0
CO2 H2S	0 0	0 0	0 0	0 0	0 0
SO2 METHANE	0 0	0 0	0 0	0 0	0 0
METHANOL	0	0	0	0	0
ETHANE ETHYLENE	0 0	0 0	0 0		0 0
C S	0 0				0 0

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	HPS-3	HPS-4	HPS-INJ	HPS-LD	LP-COND
Mole Flow Ibmol/hr					
H2O	4548.884	36960.336	33949.11	3011.226	13617.096
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0		0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	0		0	0
H2S SO2	0 0	0 0	0	0 0	0 0
			-		
METHANE METHANOL	0 0	0 0	0	0 0	0 0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
5	HPS-3	HPS-4	HPS-INJ	HPS-LD	LP-COND
Mole Frac	TFS-5	11F J - <del>1</del>	THE S-INJ	TIF J-LD	
H2O	1	1	1	1	1
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0 0	0	0
NO	0	0	0	0	0
NO2	0	0		0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
MWMX	18.015	18.015	18.015	18.015	18.015

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	LP-FW-1	LP-FW-2	LPS	LPS-1	LPS-2
Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	218 17.19 0 10895.842 196291.636 3289.082 -1312.028 LP-FW-1	60 0 10895.842 196291.636 3288.734	60 1 10895.842 196291.636 1.41E+06	292.7 60 1 10895.842 196291.636 1.41E+06 -1117.349 LPS-1	389349.857
Mass Flow lb/hr H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE METHANOL ETHANE ETHYLENE C		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
S Mass Frac H2O O2 N2 AR N0 N02 NH3 H2 CO CO CO2 H2S SO2 METHANE METHANE METHANOL ETHANE ETHYLENE	LP-FW-1 1 0 0 0 0 0 0 0 0 0 0 0 0 0	LP-FW-2	LPS 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	LPS-1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	LPS-2 1 0 0 0 0 0 0 0 0 0 0 0 0 0
C S	0	0	0	0	0

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	LP-FW-1	LP-FW-2	LPS	LPS-1	LPS-2
Mole Flow Ibmol/hr	10005 042	10005 042	10005 042	10005 042	2011 226
H2O O2	10895.842 0	10895.842 0	10895.842 0	10895.842 0	3011.226 0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0 0	0	Ő
NO2	0 0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE ETHYLENE	0 0	0 0	0 0	0 0	0 0
C	0	0	0	0	0
S	0	0	0	0	0
J	-	LP-FW-2	-	-	LPS-2
Mole Frac					
H2O	1	1	1	1	1
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3 H2	0 0	0 0	0 0	0	0 0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0 0	0	0	0	õ
S02	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
MWMX	18.015	18.015	18.015	18.015	18.015

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	LPS-3	LPS-4	LPS-DA	LPS-INJ	LPS-USRS
Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr	292.7 60 1 13907.067 250530 716	292.7 60 1 13907.067 250539.716	60 1 289.972	0	292.7 60 1 13617.096 245315.79
Volume Flow Cuft/hr	1.80E+06	1.80E+06	37493.19	0	1.76E+06
Enthalpy MMBtu/hr	-1426.145	-1426.145	-29.736		-1396.409
Mass Flow lb/hr	LPS-3	LPS-4	LPS-DA		LPS-USRS
H2O	250539.716	250539.716	5223.925		245315.79
O2	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0		0
CO	0	0	0		0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
Mass Frac	LPS-3	LPS-4	LPS-DA		LPS-USRS
H2O	1	1	1		1
O2	0	0	0		0
N2 AR	0	0	0		0 0
NO	0	0	0		0
NO2	0	0	0		0
NH3	0	0	0		0
H2	0	0	0		0
CO	0	0	0		0
CO2	0	0	0		0
H2S	0	0	0		0
S02	0	0	0		0
METHANE	0	0	0		0
METHANOL	0	0	0		0
ETHANE	0	0	0		0
ETHYLENE	0	0	0		0
C	0	0	0		0
S	0	0	0		0

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	LPS-3	LPS-4 L	PS-DA	LPS-INJ	LPS-USRS
Mole Flow lbmol/hr H2O	12007.007	12007.007	200 072	0	12017 000
H20 02	13907.067 0	13907.067 0	289.972 0	0 0	13617.096 0
N2	0	0	0	0	0
AR	Ő	0 0	0	0	Ö
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE METHANOL	0 0	0 0	0 0	0 0	0 0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0 0	0	0	0	Ö
S	0	0	0	0	0
	LPS-3	LPS-4 L	.PS-DA	LPS-INJ	LPS-USRS
Mole Frac					
H2O	1	1	1	0	1
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO NO2	0 0	0 0	0 0	0 0	0 0
NU2 NH3	0	0	0	0	0
H2	0	0	0	0	0
CO	0 0	0	0	0	Ő
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0 19.015	0	0 19.015
MWMX	18.015	18.015	18.015		18.015

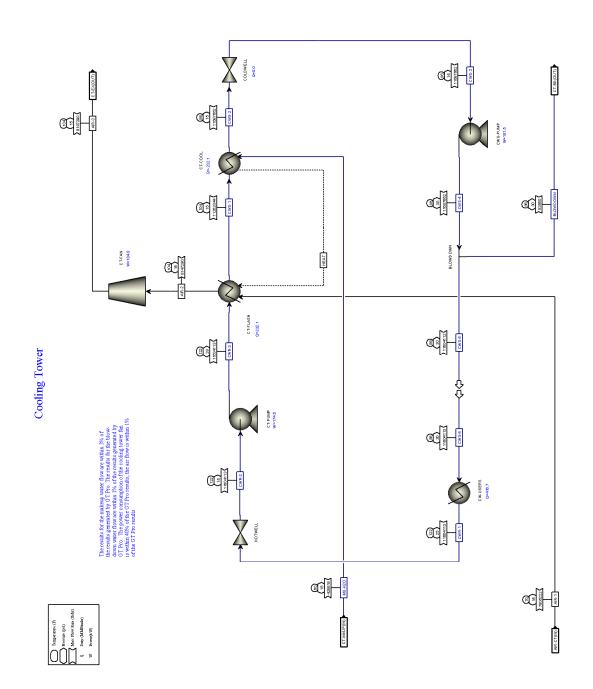
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	MAKE-UP	NAT-GAS
Temperature F Pressure psi Vapor Frac Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	92.4 14.7 33995.058 612430.499 9864.277 -4170.543 MAKE-UP	7 314.7 0 1 3 267.084 5 4589 4569.499
Mass Flow lb/hr H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE METHANE ETHYLENE C S		5 0 0 0 0.854 0 89.014 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 29.379 0 0.046 0 0 0 0 0 0.046 0 0 0
Mass Frac H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE METHANE ETHYLENE C S		NAT-GAS

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Mala Flow Ibmal/br	MAKE-UP	NAT-GAS
Mole Flow Ibmol/hr H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE METHANE ETHANE ETHYLENE C		3       0         0       0.027         0       3.178         0       0         0       0         0       0         0       0         0       0         0       0         0       0         0       0         0       0.668         0       0.001         0       249.904         0       0         10.013       0         0       0
S	( MAKE-UP	) 0 NAT-GAS
Mole Frac H2O O2 N2 AR NO NO2 NH3 H2 CO CO2 H2S SO2 METHANE METHANE ETHYLENE C S S MWMX		1       0         0       0.012         0       0.012         0       0         0       0         0       0         0       0         0       0         0       0         0       0         0       0.002         0       0.002         0       0.936         0       0.037         0       0         0       0         0       0         0       0         0       0

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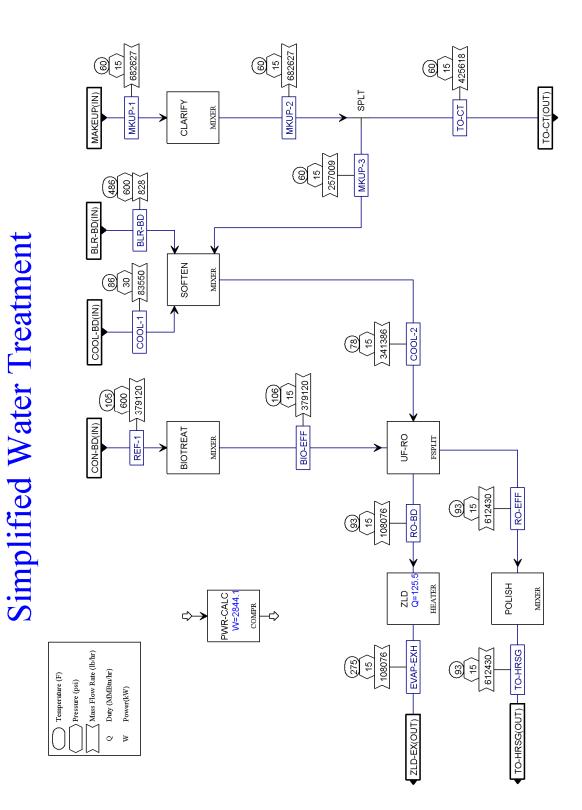
	AIR-1	AIR-2	AIR-3	BLOWDOWN	CWR-1
Temperature F	70	104	104.1	86	122
Pressure psi	14.7	14.67	14.7		25
Vapor Frac	1	0.996	0.996		0
Mole Flow lbmol/hr	270488.931	289771.942			644126.149
Mass Flow lb/hr	7.81E+06	8.15E+06	8.15E+06	83549.613	1.16E+07
Volume Flow cuft/hr	1.05E+08	1.19E+08			188117.123
Enthalpy MMBtu/hr	-305.429	-2315.929	-2315.299	-568.888	-78680.561
Dew Temp F	43.078	105.801	105.854	250.315	240.052
Mole Flow lbmol/hr					
H2O	2678.108	22438.315	22438.315	4632.186	644126.149
02	56213.492	56099.578	56099.578		0
N2		208616.832			0
AR	2517.422	2512.01	2512.01		0
NO	0	0	0		0
NO2	0	0	0		0
NH3	0	0	0		0
H2	26.781	26.777	26.777	0	0
CO	0	0	0		0
CO2	80.343	78.43	78.43		0
H2S	0	0	0		0
SO2	0	0	0		0
METHANE	0	0	0		0
ETHANE	0	0	0		0
ETHYLENE	0	0	0 0		0
METHANOL	0	0	0		0 0
C S	0	0	0		0
Mole Frac	U	U	U	U	U
H2O	0.01	0.077	0.077	0.999	1
02	0.208	0.194	0.194		0
N2	0.773	0.72	0.72		0
AR	0.009	0.009	0.009		0
NO	0	0	0		0
NO2	0	0	0		0
NH3	0	0	0		0
H2	0	0	0	0	0
СО	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
S02	0	0	0	0	0
METHANE	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
С	0	0	0		0
S	0	0	0	0	0
RELHUMID	38.956	99.924	99.924		

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	CWR-2	CWR-3	CWS-1	CWS-2	CWS-3
Temperature F	122	122	104	86	86
Pressure psi	14.7	29.39	14.67	14.67	14.7
Vapor Frac	0	0	0	0	0
Mole Flow Ibmol/hr				648468.526	
Mass Flow lb/hr	1.16E+07	1.16E+07	1.13E+07	1.17E+07	1.17E+07
Volume Flow cuft/hr	-78680.561	188116.532		187929.903	
Enthalpy MMBtu/hr Dew Temp F	211.983	-78679.966 249.146	-76437.388 211.973	-79581.678 211.904	-79581.678 211.983
Mole Flow Ibmol/hr	211.905	249.140	211.575	211.504	211.905
H2O	644126,149	644126.149	624365.942	647991.33	647991.33
02	0	0	113.914	113.914	113.914
N2	0	0	355.953	355.953	355.953
AR	0	0	5.412	5.412	5.412
NO	0	0	0	0	0
NO2	0	0	0	0	0
NH3	0	0	0	0	0
H2	0	0	0.004	0.004	0.004
CO	0	0	0	0	0
CO2	0	0	1.913	1.913	1.913
H2S SO2	0 0	0	0	0 0	0
METHANE	0	0	0	0	0 0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	Ő
METHANOL	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
Mole Frac					
H2O	1	1	0.999	0.999	0.999
02	0	0	0	0	0
N2	0	0	0.001	0.001	0.001
AR	0	0	0	0	0
NO NO2	0	0	0	0 0	0 0
NH3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
METHANOL	0	0	0	0	0
C S	0	0	0	0 0	0 0
S RELHUMID	0	0	0	U	0

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	CWS-4	CWS-5	CWS-6	MU-H2O
Temperature F	86	86	86	60
Pressure psi	30	30	30	14.7
Vapor Frac	0	0	0	0
Mole Flow Ibmol/hr	648468.526	643832.929	644126.149	23625.388
Mass Flow lb/hr	1.17E+07	1.16E+07		425617.984
Volume Flow cuft/hr	187921.419		186662.662	
Enthalpy MMBtu/hr		-79012.171		
Dew Temp F	250.315	250.315	250.316	211.983
Mole Flow lbmol/hr	647004 00	640050 444	<i></i>	
H2O			644126.149	23625.388
02	113.914	113.1	0	0
N2	355.953	353.408	0	0
AR NO	5.412 0	5.373 0	0	0 0
		0		
NO2 NH3	0 0	0	0 0	0 0
H2	0.004	0.004	0	0
CO	0.004	0.004	0	0
CO2	1.913	1.899	0	0
H2S	1.915	1.099	0	0
S02	0	0	0	0
METHANE	0	0	0	0
ETHANE	0	0	0	0
ETHYLENE	0	0	0	0
METHANOL	0	0	0	0
С	0	0	0	0
S	0	0	0	0
Mole Frac				
H2O	0.999	0.999	1	1
02	0	0	0	0
N2	0.001	0.001	0	0
AR	0	0	0	0
NO	0	0	0	0
NO2	0	0	0	0
NH3	0	0	0	0
H2	0	0	0	0
CO	0	0	0	0
CO2	0	0	0	0
H2S	0 0	0	0	0
SO2	-	0	0	0
METHANE ETHANE	0 0	0	0	0 0
ETHYLENE				
METHANOL	0 0	0 0	0 0	0 0
C	0	0	0	0
S	0	0	0	0
RELHUMID	0	0	0	0



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	BIO-EFF	BLR-BD	COOL-1	COOL-2	EVAP-EXH
Temperature F Pressure psi Vapor Frac	106.1 14.7 0	486.3 600 1	86 30 0	78.1 14.7 0	275 14.7 1
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	21042.898 379120.155	45.948	4635.597	18947.709 341386.309 7823.069	5998.591 108075.97 3.20E+06 -614.532
	BIO-EFF	BLR-BD		COOL-2	EVAP-EXH
Mass Flow lb/hr H2O O2	379022.477 0	827.772 0	83450.126 26.058	341286.822 26.058	108046.395 3.909
N2 AR	0.002 0	0	71.283 1.545	71.283	10.693 0.232
NO NO2	0	0	0	0	0
NO2 N2O4 NH3	0 44.763	0	0	0	0 6.714
HNO3 NH4NO3	0 0	0	0	0	0.714
H2 CO	0.253 0.002	0	0	0	0.038 0
CO2 H2S	52.569 0	0	0.602 0	0.602 0	7.976 0
SO2 METHANE	0 0 0.089	0	0	0	0 0.013
METHANOL ETHANE	0.089	0	0	0	0.015
ETHYLENE C	0	0	0	0	0
S UREA	0	0	0	0	0
CARB ZNO	0	0	0	0	0
ZNS C2H6S	0	0	0	0	0
C4H10S PROPANE	0	0	0	0	0
BUTANE PENTANE	0	0	0	0	0
HEXANE	0 BIO-EFF	0 BLR-BD	0	0 COOL-2	0 EVAP-EXH
Mass Frac H2O	1	1	0.999	1	
O2 N2	0	0	0.999 0 0.001	0	1 0 0
AR NO	0	0	0.001 0 0	0	0 0

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NO2	0	0	0	0	0	
N2O4	0	0	0	0	0	
NH3	0	0	0	0	0	
HNO3	0	0	0	0	0	
NH4NO3	0	0	0	0	0	
H2	0	0	0	0	0	
CO CO2	0 0	0 0	0 0	0 0	0 0	
H2S	0	0	0	0	0	
S02	0	0	0	0	0	
METHANE	0 0	0	0	0	0	
METHANOL	0	Ũ	0	0	0	
ETHANE	0	0	0	0	0	
ETHYLENE	0	0	0	0	0	
С	0	0	0	0	0	
S	0	0	0	0	0	
UREA	0	0	0	0	0	
CARB	0	0	0	0	0	
ZNO	0	0	0	0	0	
ZNS	0	0	0	0	0	
C2H6S	0 0	0	0	0	0	
C4H10S PROPANE	0	0 0	0 0	0 0	0 0	
BUTANE	0	0	0	0	0	
PENTANE	0	0	0	0	0	
HEXANE	ů 0	0 0	Ő	0	0	
	BIO-EFF B	LR-BD	COOL-1	COOL-2	EVAP-EXH	
Mole Flow Ibmol/hr						
H2O	21038.945	45.948	4632.186	18944.297	5997.486	
02	0	0	0.814	0.814	0.122	
N2	0	0	2.545	2.545	0.382	
AR	0	0	0.039	0.039	0.006	
NO	0	0	0	0	0	
NO2	0	0	0	0	0	
N2O4	0	0	0	0	0	
NH3 HNO3	2.628 0	0 0	0 0	0 0	0.394 0	
NH4NO3	0	0	0	0	0	
H2	0.125	0	0 0	0	0.019	
CO	0	0	0	0	0	
CO2	1.194	0	0.014	0.014	0.181	
H2S	0	0	0	0	0	
SO2	0	0	0	0	0	
METHANE	0.006	0	0	0	0.001	
METHANOL	0	0	0	0	0	
ETHANE	0	0	0	0	0	
ETHYLENE	0	0	0	0	0	
C	0	0	0	0	0	
S	0	0	0	0	0	

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	C C C C C C C C C C C C C C C C C C C		0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Frac H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE ETHYLENE C S			0.001 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE			0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0
MWMX	18.017	-	18.023	18.017	18.017

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	MKUP-1	MKUP-2	MKUP-3	REF-1	RO-BD
Temperature F Pressure psi Vapor Frac	60 14.7 0	14.7	60 14.7 0	104.6 600 0	92.8 14.7 0
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	37891.551	37891.551 682626.908	14266.163 257008.925	21042.898 379120.155 7234.099 -2590.846 REF-1	5998.591 108075.97 2343.661 -740.072 RO-BD
Mass Flow lb/hr H2O	692626 009	697676 009	257008.925	270022 477	108046.395
02	002020.908	002020.908	257008.925	0	3.909
N2	0	0	0	0.002	10.693
AR	0	0	0	0	0.232
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	44.763	6.714
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0.253	0.038
CO	0	0	0	0.002	0
CO2	0 0	0 0	0	52.569	7.976
H2S SO2	0	0	0 0	0	0 0
METHANE	0	0	0	0.089	0.013
METHANOL	0	0	0	0.089	0.015
ETHANE	0	0	0	0	0 0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	0	0	0	0
Mass Frac	MKUP-1	MKUP-2	MKUP-3	REF-1	RO-BD
H2O	1	1	1	1	1
02	0	0	0	0	0
N2	0	0	0	0	0
AR	0	0	0	0	0
NO	0	0	0	0	0

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NO2	0	0	0	0	0
N2O4	0	0	0		0
NH3	0	0	0		0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE	0	0	0	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0		0
ETHYLENE	0	0	0		0
C	0	0	0		0
S	0	0	0		0
UREA	0	0	0		0
CARB	0	0	0		0
ZNO	0	0	0		0
ZNS	0	0	0		0
C2H6S	0	0	0		0
C4H10S	0	0	0		0
PROPANE BUTANE	0 0	0 0	0 0		0 0
PENTANE	0	0	0		0
HEXANE	0	0	0		0
HEXANE	MKUP-1 MKUP-	-	(UP-3	-	RO-BD
Mole Flow lbmol/hr		2 10			
H2O	37891.551 3789	91.551	14266.163	21038.945	5997.486
02	0	0	0		0.122
N2	0	0	0		0.382
AR	0	0	0	0	0.006
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0		0
NH3	0	0	0		0.394
HNO3	0	0	0		0
NH4NO3	0	0	0		0
H2	0	0	0		0.019
CO	0	0	0		0
CO2	0	0	0		0.181
H2S	0	0	0		0
SO2	0	0	0		0
METHANE	0	0	0		0.001
METHANOL	0 0	0	0		0
ETHANE ETHYLENE	0	0 0	0 0		0 0
C	0	0	0		0
S	0	0	0		0
J	U	0	0	0	v

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Mole Frac				_	_
H2O	1	1	1	1	1
O2 N2	0	0 0	0	0 0	0 0
AR	0	0	0 0	0	0
NO	0	0	0	0	0
NO2	0	0	0	0	0
N2O4	0	0	0	0	0
NH3	0	0	0	0	0
HNO3	0	0	0	0	0
NH4NO3	0	0	0	0	0
H2	0	0	0	0	0
CO	0	0	0	0	0
CO2	0	0	0	0	0
H2S	0	0	0	0	0
SO2	0	0	0	0	0
METHANE METHANOL	0 0	0 0	0 0	0 0	0 0
ETHANOL	0	0	0	0	0
ETHYLENE	0	0	0	0	0
C	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0	0	0	0
ZNO	0	0	0	0	0
ZNS	0	0	0	0	0
C2H6S	0	0	0	0	0
C4H10S	0	0	0	0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
	0 18.015	0 19.015	0 19 01 F	0 19.017	0
MWMX	10.015	18.015	18.015	18.017	18.017

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	RO-EFF	то-ст	TO-HRSG	ZZ-PWR-1	ZZ-PWR-2
Temperature F Pressure psi Vapor Frac	92.8 14.7 0	60 14.7 0	14.7	14.7	360.7 50 1
Mole Flow Ibmol/hr Mass Flow Ib/hr Volume Flow cuft/hr Enthalpy MMBtu/hr	33992.016	23625.388 425617.984 7993.456	33992.016 612430.495 13280.745	4619.261 129401.566 1.75E+06	4619.261
	RO-EFF	TO-CT	TO-HRSG	ZZ-PWR-1	ZZ-PWR-2
Mass Flow lb/hr H2O	612262.904	425617.984	612262.904	0	0
02	22.149				0
N2	60.592	0	60.592	129401.566	129401.566
AR	1.314	0			0
NO	0	0			0
NO2	0	0		0	0
N2O4	0	0		0	0
NH3	38.048	0 0	38.048	0	0
HNO3 NH4NO3	0 0	0	0 0	0	0 0
H2	0.215	0		0	0
CO	0.002	0	0.002		0
CO2	45.195	0	45.195		0
H2S	0	0	0	0	0
S02	0	0		0	0
METHANE	0.076	0	0.076	0	0
METHANOL	0	0	0	0	0
ETHANE	0	0	0	0	0
ETHYLENE	0	0	0	0	0
С	0	0	0	0	0
S	0	0	0	0	0
UREA	0	0	0	0	0
CARB	0	0		0	0
ZNO ZNS	0 0	0 0	0	0	0
C2H6S	0	0	0 0	0	0 0
C4H10S	0	0		0	0
PROPANE	0	0	0	0	0
BUTANE	0	0	0	0	0
PENTANE	0	0	0	0	0
HEXANE	0	0	0	0	0
	RO-EFF	TO-CT	TO-HRSG	ZZ-PWR-1	ZZ-PWR-2
Mass Frac					
H2O	1	1			0
02	0	0			0
N2	0	0	0	1	1
AR	0	0	0	0	0
NO	0	0	0	0	0

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						_
NO2	0	0	0	0	0	
N2O4	0	0	0		0	
NH3	0	0	0	0	0	
HNO3	0	0	0	0	0	
NH4NO3	0	0	0	0	0	
H2	Ő	0	0	0	0 0	
CO	0	0	0	0	0	
CO2	0	0	0	0	0	
H2S					0	
	0	0	0	0		
SO2	0	0	0	0	0	
METHANE	0	0	0	0	0	
METHANOL	0	0	0	0	0	
ETHANE	0	0	0	0	0	
ETHYLENE	0	0	0	0	0	
C	0	0	0	0	0	
S	0	0	0	0	0	
UREA	0	0	0	0	0	
CARB	0	0	0	0	0	
ZNO	0	0	0	0	0	
ZNS	0	0	0	0	0	
C2H6S	0	0	0	0	0	
C4H10S	0	0	0	0	0	
PROPANE	0	0	0	0	0	
BUTANE	0	0	0	0	0	
PENTANE	0	0	0	0	0	
HEXANE	0	0	0	0	0	
	RO-EFF	то-ст	TO-HRSG	ZZ-PWR-1	ZZ-PWR-2	
Mole Flow lbmol/hr						
H2O	33985.756	23625.388	33985.756	0	0	
02	0.692	0	0.692		0	
N2	2.163	0	2.163		4619.261	
AR	0.033	0	0.033		0	
NO	0.055	0	0.055		0	
NO2	0	0	0		0	
N2O4	0	0	0		0	
NH3	2.234	0	2.234		0	
HNO3					0	
NH4NO3	0	0	0			
	0	0	0		0	
H2	0.106	0	0.106		0	
CO	0	0	0		0	
CO2	1.027	0	1.027		0	
H2S	0	0	0		0	
SO2	0	0	0		0	
METHANE	0.005	0	0.005		0	
METHANOL	0	0	0		0	
ETHANE	0	0	0		0	
ETHYLENE	0	0	0		0	
С	0	0	0	0	0	
S	0	0	0	0	0	

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UREA CARB ZNO ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 2Z-PWR-1	0 0 0 0 0 0 0 0 0 2Z-PWR-2
Mole Frac H2O O2 N2 AR NO NO2 N2O4 NH3 HNO3 NH4NO3 H2 CO CO2 H2S SO2 METHANE METHANE METHANE ETHYLENE C S UREA CARB ZNO	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
ZNS C2H6S C4H10S PROPANE BUTANE PENTANE HEXANE MWMX	0 0 0 0 0 18.017	0 0 0 0 0 0 18.015	0 0 0 0 0 0 18.017	0 0 0 0 0 0 28.013	0 0 0 0 0 0 28.013

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## **Appendix B High Temperature Electrolysis Results**

The model of the high-temperature steam electrolysis process and results in Appendix B were developed using HYSYS.Plant version 2.2.2 (Build 3806) from Hyprotech Ltd. on a desktop computer running Microsoft Windows XP Professional Version 2002 Service Pack 3.

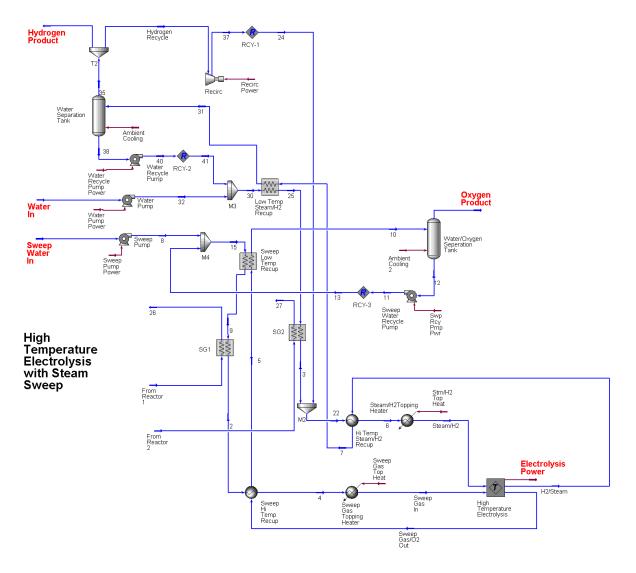


Figure B-1. Flow diagram of HTSE process.

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1				Case Name: 0	C:\Documents and Setti	ngs\mgq\Desktop\NGNI	P\FY 09 Report\600 M\
2 3	HYPROTEC	INL Calgary, /	Alberta	Unit Set:	NGNP1		
4 5		CANADA		Date/Time:	Thu Oct 01 11:50:20 20	009	
6 7 8	Woi	kbook:	Case (Main	)			
9 10				Streams			
10	Name		Steam/H2	Sweep Gas In	H2/Steam	Sweep Gas/O2 Out	15
12	Vapour Fraction		1.0000	1.0000	1.0000	1.0000	0.0000
13	Temperature	(C)	800.00 *	800.00	800.00	800.00	27.029
14	Pressure	(MPa)	5.0000 *	5.0000	5.0000	5.0000	5.2000
15	Molar Flow	(kgmole/h)	5169.3	1551.2	5169.3	3101.9	1551.2
16	Mass Flow	(kg/s)	23.571 *	7.7631	9.7869	21.547	7.7631 *
17	Liquid Volume Flow	(m3/h)	98.90	28.00	132.4	71.62	28.00
18	Heat Flow	(kW)	-2.712e+005	-9.151e+004	-6.830e+004	-8.053e+004	-1.229e+005
19	Molar Enthalpy	(kJ/kgmole)	-1.888e+005	-2.124e+005	-4.757e+004	-9.346e+004	-2.851e+005
20	Name		22	Sweep Water In	24	25	Water In
21	Vapour Fraction		1.0000	0.0000	1.0000	0.1491	0.0000
22	Temperature	(C)	603.79	26.850 *	30.717 *	267.01	26.850 *
23	Pressure	(MPa)	5.1000	0.10132 *	5.1000 *	5.1500	0.10132 *
24	Molar Flow	(kgmole/h)	5169.3	14.749	517.29 *	4652.1	3104.1
25 26	Mass Flow	(kg/s)	23.571	7.3805e-002	0.29162	23.279	15.534
	Liquid Volume Flow	(m3/h)	98.90 -2.828e+005	0.2662	14.92	83.98 -3.365e+005	56.03
27 28	Heat Flow	(kW)	-2.828e+005 -1.969e+005		-5.776 -40.20		-2.460e+005
20 29	Molar Enthalpy Name	(kJ/kgmole)	32	-2.853e+005 41	-40.20	-2.604e+005 31	-2.853e+005 35
29 30	Vapour Fraction		0.0000	0.0000	0.0000	0.8062	1.0000
31	Temperature	(C)	27.299	26.026 *	26.876	157.63	26.000
32	Pressure	(O) (MPa)	5.2000	5.2000 *	5.2000	4.9000	4.9000
33	Molar Flow	(kgmole/h)	3104.1	1548.0 *	4652.1	5169.3	3621.5
34	Mass Flow	(kg/s)	15.534	7.7459	23.279	9.7869	2.0416
35	Liquid Volume Flow	(m3/h)	56.03	27.94	83.98	132.4	104.5
36	Heat Flow	(HU)	-2.459e+005	-1.226e+005	-3.685e+005	-1.088e+005	-177.1
37	Molar Enthalpy	(kJ/kgmole)	-2.851e+005	-2.852e+005	-2.852e+005	-7.580e+004	-176.0
38	Name	(	38	37	Hydrogen Product	Hydrogen Recycle	40
39	Vapour Fraction		0.0000	1.0000	1.0000	1.0000	0.0000
40	Temperature	(C)	26.000 *	30.717	26.000	26.000	26.026
41	Pressure	(MPa)	4.9000	5.1000	4.9000	4.9000	5.2000
42	Molar Flow	(kgmole/h)	1547.8	517.29	3104.2	517.29 *	1547.8
43	Mass Flow	(kg/s)	7.7453	0.29162	1.7500	0.29162	7.7453
44	Liquid Volume Flow	(m3/h)	27.94	14.92	89.55	14.92	27.94
45	Heat Flow	(kW)	-1.226e+005	-5.776	-151.8	-25.30	-1.226e+005
46	Molar Enthalpy	(kJ/kgmole)	-2.852e+005	-40.20	-176.0	-176.0	-2.852e+005
47	Name		From Reactor 1	From Reactor 2	26	27	2
48	Vapour Fraction		1.0000	1.0000	1.0000	1.0000	1.0000
49	Temperature	(C)	700.00 *	700.00 *	353.00 *	318.00 *	650.00 *
50	Pressure	(MPa)	7.0000 *	7.0000 *	6.9300	6.9300	5.1000
							1551.2
	Molar Flow	(kgmole/h)	3659.0	24376	3659.0	24376	7 700 1
51 52	Mass Flow	(kg/s)	4.0685	27.105	4.0685	27.105	7.7631
52 53	Mass Flow Liquid Volume Flow	(kg/s) (m3/h)	4.0685 118.1	27.105 786.5	4.0685 118.1	27.105 786.5	28.00
52 53 54	Mass Flow Liquid Volume Flow Heat Flow	(kg/s) (m3/h) (kW)	4.0685 118.1 1.433e+004	27.105 786.5 9.548e+004	4.0685 118.1 7004	27.105 786.5 4.174e+004	28.00 -9.428e+004
52 53 54 55	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy	(kg/s) (m3/h)	4.0685 118.1 1.433e+004 1.410e+004	27.105 786.5 9.548e+004 1.410e+004	4.0685 118.1 7004 6891	27.105 786.5 4.174e+004 6164	28.00 -9.428e+004 -2.188e+005
52 53 54 55 56	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name	(kg/s) (m3/h) (kW)	4.0685 118.1 1.433e+004 1.410e+004 4	27.105 786.5 9.548e+004 1.410e+004 5	4.0685 118.1 7004 6891 3	27.105 786.5 4.174e+004 6164 9	28.00 -9.428e+004 -2.188e+005 10
52 53 54 55 56 57	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction	(kg/s) (m3/h) (kW) (kJ/kgmole)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000	27.105 786.5 9.548e+004 1.410e+004 5 1.0000	4.0685 118.1 7004 6891 3 1.0000	27.105 786.5 4.174e+004 6164 9 0.9732	28.00 -9.428e+004 -2.188e+005 10 0.8442
52 53 54 55 56 57 58	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature	(kg/s) (m3/h) (kW) (kJ/kgmole) (C)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55	4.0685 118.1 7004 6891 3 1.0000 650.00 *	27.105 786.5 4.174e+004 6164 9 0.9732 267.01	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14
52 53 54 55 56 57 58 59	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure	(kg/s) (m3/h) (kW) (kJ/kgmole) (C) (MPa)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55 4.9500	4.0685 118.1 7004 6891 3 1.0000 650.00 ° 5.1000	27.105 786.5 4.174e+004 9 0.9732 267.01 5.1500	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 4.9000
52 53 54 55 56 57 58 59 60	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure Molar Flow	(kg/s) (m3/h) (kW) (kJ/kgmole) (C) (MPa) (kgmole/h)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500 1551.2	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55	4.0685 118.1 7004 891 3 1.0000 650.00 ' 5.1000 4652.1	27.105 786.5 4.174e+004 6164 9 0.9732 267.01	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 4.9000 3101.9
52 53 54 55 56 57 58 59 60 61	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure Molar Flow Mass Flow	(kg/s) (m3/h) (kW) (kJ/kgmole) (C) (MPa) (kgmole/h) (kg/s)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500 1551.2 7.7631	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55 4.9500 3101.9 21.547	4.0685 118.1 7004 6891 3 1.0000 650.00 ° 5.1000 4652.1 23.279	27.105 786.5 4.174e+004 6164 9 0.9732 267.01 5.1500 1551.2 7.7631	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 4.9000 3101.9 21.547
52 53	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure Molar Flow	(kg/s) (m3/h) (kW) (kJ/kgmole) (C) (MPa) (kgmole/h)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500 1551.2	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55 4.9500 3101.9	4.0685 118.1 7004 891 3 1.0000 650.00 ' 5.1000 4652.1	27.105 786.5 4.174e+004 6164 9 0.9732 267.01 5.1500 1551.2	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 4.9000 3101.9
52 53 54 55 56 57 58 59 60 61 62	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure Molar Flow Mass Flow Liquid Volume Flow	(kg/s) (m3/h) (kW) (kJ/kgmole) (kgmole/h) (kg/s) (m3/h)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500 1551.2 7.7631 28.00	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55 4.9500 3101.9 21.547 71.62	4.0685 118.1 7004 6891 3 1.0000 650.00 ° 5.1000 4652.1 23.279 83.98	27.105 786.5 4.174e+004 9 0.9732 267.01 5.1500 1551.2 7.7631 28.00	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 -4.9000 3101.9 21.547 71.62
52 53 54 55 56 57 58 60 61 62 63	Mass Flow Liquid Volume Flow Heat Flow Molar Enthalpy Name Vapour Fraction Temperature Pressure Molar Flow Mass Flow Liquid Volume Flow Heat Flow	(kg/s) (m3/h) (kW) (kJ/kgmole) (kgmole/h) (kg/s) (m3/h) (kW)	4.0685 118.1 1.433e+004 1.410e+004 4 1.0000 780.00 5.0500 1551.2 7.7631 28.00 -9.189e+004	27.105 786.5 9.548e+004 1.410e+004 5 1.0000 728.55 4.9500 3101.9 21.547 71.62 -8.292e+004	4.0685 118.1 7004 6891 3 1.0000 650.00 * 5.1000 4652.1 23.279 83.98 -2.828e+005	27.105 786.5 4.174e+004 9 0.9732 267.01 5.1500 1551.2 7.7631 28.00 -1.016e+005	28.00 -9.428e+004 -2.188e+005 10 0.8442 207.14 4.9000 3101.9 21.547 71.62 -1.042e+005

Appendix B

Identifier:	TEV-693	
Revision:	1	
Effective Date:	05/15/10	Page: 114 of 151

1	2		Case Name:		nac/maa/Dockton/MGM	P\FY 09 Report\600 MV
2	INL				ngs ingqibeskiop i vori	
3 4	Calgary, Calgary, CANADA	Alberta	Unit Set:	NGNP1		
4 5	CARADA		Date/Time:	Thu Oct 01 11:50:20 20	009	
6						
7	Workbook:	Case (Main	i) (continue	ed)		
8 9						
10			Streams (continu	ied)		
11	Name	Oxygen Product	12	6	7	8
12	Vapour Fraction	1.0000	0.0000	1.0000	1.0000	0.0000
13 14	Temperature (C) Pressure (MPa)	27.000 * 4.9000	27.000 4.9000	748.90 5.0500	623.79 4.9500	27.299 5.2000
15	Molar Flow (kgmole/h)	1552.4	1549.5	5169.3	5169.3	14.749
16	Mass Flow (kg/s)	13.793	7.7547	23.571	9.7869	7.3805e-002
17	Liquid Volume Flow (m3/h)	43.65	27.97	98.90	132.4	0.2662
18	Heat Flow (KW)	-279.2	-1.227e+005	-2.742e+005	-7.687e+004	-1168
19	Molar Enthalpy (kJ/kgmole)	-647.4	-2.851e+005	-1.910e+005	-5.354e+004	-2.851e+005
20	Name	11	13	Process Heat 1	Electrolysis Power	Water Pump Power
21	Vapour Fraction	0.0000	0.0000			
22	Temperature (C)	27.026	27.026 *			
23	Pressure (MPa)	5.2000 *	5.2000 *			
24 25	Molar Flow (kgmole/h)	1549.5	1536.4 *			
25 26	Mass Flow (kg/s)	7.7547	7.6893			
26 27	Liquid Volume Flow (m3/h) Heat Flow (kW)	27.97 -1.227e+005	27.74 -1.217e+005	 -4.865e-005	 -2.138e+005	 105.0
28	Molar Enthalpy (kJ/kgmole)	-2.851e+005	-2.851e+005	-4.0056-005	-2.13061005	
29	Name	Recirc Power	Ambient Cooling	Water Recycle Pump	Stm/H2 Top Heat	Sweep Gas Top Heat
30	Vapour Fraction					
31	Temperature (C)					
32	Pressure (MPa)					
33	Molar Flow (kgmole/h)					
34	Mass Flow (kg/s)					
35	Liquid Volume Flow (m3/h)					
36	Heat Flow (KW)	19.52	-1.397e+004	3.074	3070	374.8
37	Molar Enthalpy (kJ/kgmole)					
20	Manaa	Courses Domes Domes	Ameliant Ocaline O			
38 30	Name	Sweep Pump Power	Ambient Cooling 2	Swp Rcy Pmp Pwr		
39	Vapour Fraction	Sweep Pump Power	Ambient Cooling 2	Swp Rcy Pmp Pwr		
39 40	Vapour Fraction Temperature (C)	Sweep Pump Power	Ambient Cooling 2	Swp Rcy Pmp Pwr  		
39	Vapour FractionTemperature(C)Pressure(MPa)					
39 40 41	Vapour FractionTemperature(C)Pressure(MPa)					
39 40 41 42 43 44	Vapour Fraction           Temperature         (C)           Pressure         (MPa)           Molar Flow         (kgmole/h)					
39 40 41 42 43	Vapour Fraction       Temperature     (C)       Pressure     (MPa)       Molar Flow     (kgmole/h)       Mass Flow     (kg/s)					
39 40 41 42 43 44 45 46	Vapour Fraction       Temperature     (C)       Pressure     (MPa)       Molar Flow     (kgmole/h)       Mass Flow     (kg/s)       Liquid Volume Flow     (m3/h)					
39 40 41 42 43 44 45 46 47	Vapour Fraction       Temperature     (C)       Pressure     (MPa)       Molar Flow     (kgmole/h)       Mass Flow     (kg/s)       Liquid Volume Flow     (m3/h)       Heat Flow     (kW)	    0.4988				
39 40 41 42 43 44 45 46	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)	    0.4988 	    -1.883e+004  Composition	    3.079 	Sweep Gas/O2 Out	15
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> </ol>	Vapour Fraction       Temperature     (C)       Pressure     (MPa)       Molar Flow     (kgmole/h)       Mass Flow     (kg/s)       Liquid Volume Flow     (m3/h)       Heat Flow     (kW)	    0.4988	    -1.883e+004 		Sweep Gas/O2 Out 0.00000	15 0.00000
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)	   0.4988  Steam/H2	   -1.883e+004  <b>Composition</b> Sweep Gas In	    3.079  H2/Steam		
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)	   0.4988  Steam/H2 0.10000	    -1.883e+004  <b>Composition</b> Sweep Gas In 0.00000	    3.079  H2/Steam 0.70000	0.00000 0.50000 0.50000	0.00000
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> </ol>	Vapour Fraction Temperature (C) Pressure (MPa) Molar Flow (kgmole/h) Mass Flow (kg/s) Liquid Volume Flow (m3/h) Heat Flow (kJ/kgmole) Molar Enthalpy (kJ/kgmole) Name Comp Mole Frac (Hydrogen) Comp Mole Frac (H2O) Comp Mole Frac (Oxygen)	    0.4988  Steam/H2 0.10000 0.90000	    -1.883e+004  <b>Composition</b> Sweep Gas In 0.00000 0.99986	H2/Steam 0.70000 0.30000	0.00000	0.00000 0.99986
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> <li>54</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (Oxygen)         Comp Mole Frac (Oxygen)       Comp Mole Frac (CO2)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000	       	H2/Steam H2/Steam 0.70000 0.00000 0.00000	0.00000 0.50000 0.50000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> <li>54</li> <li>55</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kU/W)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (CXygen)         Comp Mole Frac (Oxtrogen)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Argon)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000		H2/Steam H2/Steam H2/Steam	0.00000 0.50000 0.50000 0.00000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> <li>54</li> <li>55</li> <li>56</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (H2O)         Comp Mole Frac (Nitrogen)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Argon)         Comp Mole Frac (Hzon)       Comp Mole Frac (Hzon)         Comp Mole Frac (CO2)       Comp Mole Frac (CO2)	    0.4988  0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000	        	H2/Steam H2/Steam H2/Steam	0.00000 0.50000 0.50000 0.00000 0.00000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 0.00000
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> <li>54</li> <li>56</li> <li>57</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (HzO)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (Nitrogen)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Helium)         Name       Name	    0.4988  0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22	        	H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000	0.00000 0.50000 0.00000 0.00000 0.00000 0.00000 0.00000 25	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 0.00000 Water In
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>52</li> <li>53</li> <li>54</li> <li>57</li> <li>58</li> </ol>	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (Cozyen)         Comp Mole Frac (Nitrogen)       Comp Mole Frac (Co2)         Comp Mole Frac (Argon)       Comp Mole Frac (Helium)         Name       Comp Mole Frac (Helium)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000		H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	0.00000 0.50000 0.00000 0.00000 0.00000 0.00000 25 0.00002	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 0.00000 Water In 0.00000 *
<ol> <li>39</li> <li>40</li> <li>41</li> <li>42</li> <li>43</li> <li>44</li> <li>45</li> <li>46</li> <li>47</li> <li>48</li> <li>49</li> <li>50</li> <li>51</li> <li>55</li> <li>56</li> <li>57</li> <li>58</li> <li>59</li> </ol>	Vapour Fraction Temperature (C) Pressure (MPa) Molar Flow (kgmole/h) Mass Flow (kg/s) Liquid Volume Flow (m3/h) Heat Flow (kVV) Molar Enthalpy (kJ/kgmole) Name Comp Mole Frac (Hydrogen) Comp Mole Frac (Hydrogen) Comp Mole Frac (Nitrogen) Comp Mole Frac (CO2) Comp Mole Frac (CO2) Comp Mole Frac (CO2) Comp Mole Frac (Helium) Name Comp Mole Frac (Hydrogen) Comp Mole Frac (Hydrogen) Comp Mole Frac (Hydrogen)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000 0.90000	       	H2/Steam H2/Steam 0.70000 0.30000 0.000000	0.00000 0.50000 0.00000 0.00000 0.00000 0.00000 25 0.00002 0.99998	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 0.00000 Water In 0.00000 * 1.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           59           60	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Co2)         Comp Mole Frac (Co2)       Comp Mole Frac (Argon)         Comp Mole Frac (Argon)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (H2Q)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2Q)       Comp Mole Frac (Oxygen)	    0.4988  Steam/H2 0.10000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 22 0.10000 0.90000	       	H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 *	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.99998 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 1.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           59           60           61	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (Oxygen)         Comp Mole Frac (CO2)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (H2O)         Comp Mole Frac (Coxygen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (Noter)       Comp Mole Frac (Noter)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000 0.90000 0.00000	       	H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 24 0.00084 * 0.00008 *	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.99998 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 0.00000 * 0.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           59           60           61           62	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kU/W)         Molar Enthalpy       (kJ/kgmole)         Name       (kU/M)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (H2O)         Comp Mole Frac (CO2)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (CO2)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (HzO)       Comp Mole Frac (Myrogen)         Comp Mole Frac (Myrogen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (Nitrogen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (Nitrogen)       Comp Mole Frac (CO2)	     0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000 0.00000 0.00000 0.00000	       	H2/Steam H2/Steam H2/Steam 0.70000 0.30000 0.00000 0.00000 0.00000 0.00000 24 0.99916 * 0.000084 * 0.000084 *	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.99998 0.00000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 0.00000 * 0.00000 * 0.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           60           61	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       Comp Mole Frac (Hydrogen)         Comp Mole Frac (H2O)       Comp Mole Frac (Oxygen)         Comp Mole Frac (CO2)       Comp Mole Frac (CO2)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (H2O)         Comp Mole Frac (Coxygen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (Noter)       Comp Mole Frac (Noter)	    0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000 0.90000 0.00000	       	H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 24 0.00084 * 0.00008 *	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.99998 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 0.00000 * 0.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           59           60           61           62           63	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       (kJ/kgmole)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Oxygen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (CO2)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (Mydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (Mydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (CO2)<	    0.4988  0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 22 0.10000 0.90000 0.90000 0.00000 0.00000 0.00000	       	        	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.9998 0.00000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 0.00000 * 0.00000 * 0.00000 * 0.00000 * 0.00000 *
39           40           41           42           43           44           45           46           47           48           49           50           51           52           53           54           55           56           57           58           59           60           61           62           63	Vapour Fraction         Temperature       (C)         Pressure       (MPa)         Molar Flow       (kgmole/h)         Mass Flow       (kg/s)         Liquid Volume Flow       (m3/h)         Heat Flow       (kW)         Molar Enthalpy       (kJ/kgmole)         Name       (kJ/kgmole)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Oxygen)       Comp Mole Frac (Nitrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (CO2)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Hydrogen)         Comp Mole Frac (Hydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (Mydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (Mydrogen)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (CO2)       Comp Mole Frac (Mydrogen)         Comp Mole Frac (CO2)<	    0.4988  0.4988  Steam/H2 0.10000 0.90000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000	       	H2/Steam H2/Steam H2/Steam 0.70000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 24 0.99916 ' 0.00004 ' 0.00000 '	0.00000 0.50000 0.00000 0.00000 0.00000 25 0.00002 0.9998 0.00000 0.00000 0.00000	0.00000 0.99986 0.00014 0.00000 0.00000 0.00000 Water In 0.00000 * 0.00000 * 0.00000 * 0.00000 * 0.00000 * 0.00000 *

Appendix B

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### NUCLEAR-INTEGRATED HYDROGEN **PRODUCTION ANALYSIS**

Identifier:	TEV-693	
Revision:	1	
Effective Date:	05/15/10	Page: 115 of 1

1			Case Name:	C:\Documents and Sett	inas\maa\Desktop\NGN	P\FY 09 Report\600 MV
2 3	INL	) Un				
3	HYPROTECH Calgary, A CANADA	лрепа		NGNP1		
5			Date/Time:	ne: Thu Oct 01 11:50:20 2009		
6	Workbook	Cooo (Main	) (continue	\d\		
7 8	Workbook:	Case (Main	) (continue	ea)		
9		Co	mposition (cont	inued)		
10 11	Name	32	41	30	31	35
12	Comp Mole Frac (Hydrogen)	0.00000	0.00005 *	0.00002	0.70000	0.99916
13	Comp Mole Frac (H2O)	1.00000	0.99995 *	0.99998	0.30000	0.00084
14	Comp Mole Frac (Oxygen)	0.00000	0.00000 *	0.00000	0.00000	0.00000
15	Comp Mole Frac (Nitrogen)	0.00000	0.00000 *	0.00000	0.00000	0.00000
16	Comp Mole Frac (CO2)	0.00000	0.00000 *	0.00000	0.00000	0.00000
17	Comp Mole Frac (Argon)	0.00000	0.00000 *	0.00000	0.00000	0.00000
18	Comp Mole Frac (Helium)	0.00000	0.00000 *	0.00000	0.00000	0.00000
19	Name	38	37	Hydrogen Product	Hydrogen Recycle	40
20	Comp Mole Frac (Hydrogen)	0.00005	0.99916	0.99916	0.99916	0.00005
21	Comp Mole Frac (H2O)	0.99995	0.00084	0.00084	0.00084	0.99995
22	Comp Mole Frac (Oxygen)	0.00000	0.00000	0.00000	0.00000	0.00000
23	Comp Mole Frac (Nitrogen)	0.00000	0.00000	0.00000	0.00000	0.00000
24	Comp Mole Frac (CO2)	0.00000	0.00000	0.00000	0.00000	0.00000
25	Comp Mole Frac (Argon)	0.00000	0.00000	0.00000	0.00000	0.00000
26	Comp Mole Frac (Helium)	0.00000	0.00000	0.00000	0.00000	0.00000
27	Name	From Reactor 1	From Reactor 2	26	27	2
28	Comp Mole Frac (Hydrogen)	* 000000 *	0.00000 *	0.00000	0.00000	0.00000
29	Comp Mole Frac (H2O)	* 000000	* 0.00000 *	0.00000	0.00000	0.99986
30	Comp Mole Frac (Oxygen)	0.00000 *	* 0.00000 *	0.00000	0.00000	0.00014
31	Comp Mole Frac (Nitrogen)	0.00000 *	0.00000 *	0.00000	0.00000	0.00000
32	Comp Mole Frac (CO2)	0.00000 *	0.00000 *	0.00000	0.00000	0.00000
33	Comp Mole Frac (Argon)	0.00000 *	0.00000 *	0.00000	0.00000	0.00000
34 35	Comp Mole Frac (Helium)	1.00000 *	1.00000 *	1.00000	1.00000	0.00000
35 36	Name	4	5	3	9	10
30 37	Comp Mole Frac (Hydrogen)	0.00000	0.00000	0.00002	0.00000	0.00000
38	Comp Mole Frac (H2O) Comp Mole Frac (Oxygen)	0.99986	0.50000	0.99998	0.99986	0.50000
39	Comp Mole Frac (Oxygen)	0.0000	0.00000	0.00000	0.00000	0.00000
40	Comp Mole Frac (CO2)	0.00000	0.00000	0.00000	0.00000	0.00000
41	Comp Mole Frac (Argon)	0.00000	0.00000	0.00000	0.00000	0.00000
42	Comp Mole Frac (Helium)	0.00000	0.00000	0.00000	0.00000	0.00000
43	Name	Oxygen Product	12	6	7	8
44	Comp Mole Frac (Hydrogen)	0.00000	0.00000	0.10000	0.70000	0.00000
45	Comp Mole Frac (H2O)	0.00000	0.99986	0.90000	0.30000	1.00000
46	Comp Mole Frac (Oxygen)	0.99891	0.00014	0.00000	0.00000	0.00000
47	Comp Mole Frac (Nitrogen)	0.00000	0.00000	0.00000	0.00000	0.00000
48	Comp Mole Frac (CO2)	0.00000	0.00000	0.00000	0.00000	0.00000
49	Comp Mole Frac (Argon)	0.00000	0.00000	0.00000	0.00000	0.00000
50	Comp Mole Frac (Helium)	0.00000	0.00000	0.00000	0.00000	0.00000
51	Name	11	13			
52	Comp Mole Frac (Hydrogen)	0.00000	0.00000 *			
53	Comp Mole Frac (H2O)	0.99986	0.99986 *			
54	Comp Mole Frac (Oxygen)	0.00014	0.00014 *			
55	Comp Mole Frac (Nitrogen)	0.00000	0.00000 *			
56	Comp Mole Frac (CO2)	0.00000	0.00000 *			
57	Comp Mole Frac (Argon)	0.00000	0.00000 *			
58	Comp Mole Frac (Helium)	0.00000	0.00000 *			
59			Coolers			
60						
61	Name					
62	Duty (kW)					
63	Feed Temperature (C)					
	Product Temperature (C)			1		
64						
	Hyprotech Ltd.	1.1577	SYS.Plant v2.2.2 (Buil	4 2806)	·	Page 3 of 14

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1	<b>N</b>				Case Name:	C:\Documents and Setti	nas/maa/D	eskton\NGNP	EX 09 Report\600 MV
2		INL					ngoangqaz	-contoputoru	
3 4	HYPROTECH	Calgary, A	lberta		Unit Set: 1	NGNP1			
4				Date/Time:	Thu Oct 01 11:50:20 20	09			
6									
7	Workb	ook:	Case (Ma	in)	(continue	d)			
8 9				-	•	-			
9 10				н	leat Exchange	s			
11	Name		Sweep Hi Temp R	leci H	li Temp Steam/H2 R				
12	Duty	(kW)	239		8571				
13	UA	(kJ/C-h)	2.021e+00		9.275e+005				
14	LMTD	(C)	42.6		33.27		-		
15 16	Minimum Approach	(C)	20.0		20.00				
17					Heaters				
18	Name		Steam/H2Topping	He S	weep Gas Topping				
19	Duty	(kW)	307		374.8				
20	Feed Temperature	(C)	748.	.9	780.0				
21	Product Temperature	(C)	800.	.0 *	800.0				
22					LNGs				
23 24	Name		Low Temp Steam	1U2 C	G1	SG2	Sween	ow Temp Re	
24 25	UA (Calculated)	(kJ/C-h)	1.007e+00		3.515e+005	1.425e+006	· · · ·	.0w Temp Re .161e+005	
26	LMTD	(KJ/C-II) (C)	114.		75.07 *	135.8 *	0	124.1 *	
27	Exchanger Cold Duty	(kW)	3.197e+00		7329	5.375e+004	2	124e+004	
28	Minimum Approach	(C)	50.0		50.00	50.00		50.00	
29	••				C				
30					Compressors				
31	Name		Recirc						
32	Feed Pressure	(MPa)	4.90						
33	Product Pressure	(MPa)	5.10						
34 35		kgmole/h)	517.						
30 36	Energy	(kW)	19.5	5 *					
37	Adiabatic Efficiency Polytropic Efficiency			5					
38									
39					Expanders				
40	Name								
41	Feed Pressure	(MPa)							
42	Product Pressure	(MPa)							
43		kgmole/h)							
44	Energy	(kW)		_					
45 46	Adiabatic Efficiency Polytropic Efficiency						l		
40 47	Forytropic Enrolency		1						
48					Pumps				
49	Name		Water Pump	N I	Vater Recycle Pump	Sweep Pump	Sweep \	Vater Recyc	
50	Delta P	(kPa)	509		300.0	5099		300.0	
51	Energy	(kW)	105.	.0	3.074	0.4988		3.079	
52	Feed Pressure	(MPa)	0.101		4.900	0.1013 *		4.900	
53	Product Pressure	(MPa)	5.20		5.200	5.200		5.200 *	
54		kgmole/h)	310		1548	14.75		1549	
55 56	Adiabatic Efficiency	(%)	75.0	iu :	75.00 *	75.00 *		75.00 *	
57					Unit Ops				
58	Operation Name	Ope	eration Type		Feeds	Products		Ignored	Calc. Level
59				Stean		H2/Steam			
60	High Temperature Electrolys	Standard	Sub-Flowsheet		p Gas In	Sweep Gas/O2 Ou		No	2500 *
61				Proce	ess Heat 1	Electrolysis Power	r		
62	Electrolysis Input and Outpu							No	500.0 *
63	Efficiency	Spreads	neet	6		Steem# 12		No	500.0 *
64 65	Steam/H2Topping Heater	Heater	-	-	l2 Top Heat	Steam/H2		No	500.0 *
66	Hyprotech Ltd.				6.Plant v2.2.2 (Build	13806)			Page 4 of 14
00	Licensed to: INI								* Specified by user

Licensed to: INL

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2         3           4         5           5         Workl           6         Workl           7         Workl           8         Workl           9         10           11         Operation Name           12         Sweep Gas Topping Heate           14         T2           15         Sweep Hi Temp Recup           16         T2           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         SG1           34         SG1           35         Sweep Low Temp Recup           36         SG2           33         SG2           34         SG1           35         Sweep Nump           40         Sweep Pump           41         Sweep Pump           42         Sweep Pump           43         Sweep Recycle Pum           44         Water/Oxygen Seperation Tank           45         Water/Oxygen Seperation           56         ADJ-1      <		Case Name:	C:\Documents and Settings\mg	q\Desktop\NGNP\F	Y 09 Report\600 MV			
4         Image: mail of the system           6         Image: mail of the system           7         Image: mail of the system           8         Image: mail of the system           9         Image: mail of the system           10         Image: mail of the system           11         Operation Name           12         Sweep Gas Topping Heate           14         T2           15         T2           16         Sweep Hi Temp Recup           17         M2           22         M3           23         M4           26         Recirc           27         Recirc           28         Low Temp Steam/H2 Recup           30         SG1           31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           35         Sweep Pump           40         Sweep Pump           41         Sweep Water Recycle Pum           42         Sweep Water Recycle Pum           43         Sweep Vater Separation Tank           44         Water/Oxygen Seperation           45         Water/Oxygen	INL Calgary, Alberta	Unit Set:	NGNP1					
6         Workl           8         9           10         10           11         Operation Name           12         Sweep Gas Topping Heate           14         T2           15         T2           16         Sweep Hi Temp Recup           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           19         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           24         M4           25         Recirc           26         Recirc           27         Recirc           28         SG1           30         SG1           31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           36         Sweep Pump           41         Sweep Pump           42         Sweep Pump           43         Water Separation Tank           46         Vater Separation Tank           46         Vater/Oxygen Seperation           47         SET-1 <td>CANADA</td> <td></td> <td colspan="3">Date/Time: Thu Oct 01 11:50:20 2009</td>	CANADA		Date/Time: Thu Oct 01 11:50:20 2009					
8         0           10         Operation Name           12         Sweep Gas Topping Heate           14         T2           15         T2           16         Name           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           19         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         M3           24         M4           25         M4           26         Recirc           27         Recirc           28         SG1           30         SG1           31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           35         Sweep Pump           40         Sweep Pump           41         Sweep Pump           42         Water Separation Tank           46         Water/Oxygen Seperation           43         SET-1           44         SET-2           55         ADJ-1								
10         Operation Name           11         Operation Name           12         Sweep Gas Topping Heate           14         T2           15         T2           16         Sweep Hi Temp Recup           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           19         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         M4           26         Recirc           27         Recirc           28         Low Temp Steam/H2 Recup           30         SG1           31         SG2           33         SG2           34         Sweep Low Temp Recup           35         Sweep Nump           40         Sweep Pump           41         Sweep Water Recycle Pur           42         Water Separation Tank           45         Water/Oxygen Seperation           49         SET-1           40         SET-1           41         SET-2           42         RCY-3           43         SET-2	Workbook: Case (Main) (continued)							
12         Sweep Gas Topping Heate           14         T2           15         T2           16         Sweep Hi Temp Recup           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         M4           26         Recirc           27         Recirc           28         SG1           30         SG1           31         SG1           32         SG2           34         SWeep Low Temp Recup           35         Sweep Low Temp Recup           36         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Pump           43         Water Separation Tank           46         Water/Oxygen Seperation           44         SET-1           45         SET-1           46         SET-2           56         ADJ-1           57         SE           58         Se           59         SE		Unit Ops (continu	ied)					
13         Sweep Gas Topping Heate           14         T2           16         Sweep Hi Temp Recup           17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         M4           26         Recirc           27         Recirc           28         Low Temp Steam/H2 Recu           30         SG1           31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           36         Water Pump           37         Water Recycle Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           43         Sweep Rump           44         Water/Oxygen Seperation           45         Water/Oxygen Seperation           46         Fr.1           47         SET-1           48         SET-2           55         ADJ-1           56         Fr.2           57         SE           58	Operation Type	Feeds	Products	Ignored	Calc. Level			
15       T2         16       Sweep Hi Temp Recup         17       Sweep Hi Temp Recup         18       Hi Temp Steam/H2 Recup         20       M2         21       M3         22       M3         23       M4         26       Recirc         27       Recirc         28       Low Temp Steam/H2 Recup         30       SG1         31       SG1         32       SG2         34       Sweep Low Temp Recup         36       Water Pump         39       Water Recycle Pump         40       Sweep Pump         41       Sweep Water Recycle Pur         42       Sweep Water Recycle Pur         44       Water/Oxygen Seperation Tank         45       Water/Oxygen Seperation         49       SET-1         50       RCY-1         51       RCY-2         52       RCY-3         53       SET-1         54       SET-2         55       ADJ-1         56       ADJ-1         57       S         58       ADJ-1         59 </td <td>r Heater</td> <td>4 Sweep Gas Top Heat</td> <td>Sweep Gas In</td> <td>No</td> <td>500.0 *</td>	r Heater	4 Sweep Gas Top Heat	Sweep Gas In	No	500.0 *			
17         Sweep Hi Temp Recup           18         Hi Temp Steam/H2 Recup           20         M2           21         M3           22         M3           23         M4           26         Recirc           27         Recirc           28         Low Temp Steam/H2 Recup           29         Low Temp Steam/H2 Recup           30         SG1           31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           35         Sweep Pump           40         Sweep Pump           41         Sweep Water Recycle Pur           42         Sweep Water Recycle Pur           43         Sweep Water Separation Tank           44         Water/Oxygen Seperation           49         SET-1           50         RCY-3           51         SET-1           52         ADJ-1           56         ADJ-1           57         SE           59         ADJ-1	Тее	35	Hydrogen Product Hydrogen Recycle	No	500.0 *			
Hi Temp Steam/H2 Recup           20         M2           21         M2           22         M3           23         M4           25         M4           26         Recirc           27         Recirc           28         Low Temp Steam/H2 Recu           30         SG1           31         SG1           32         SG2           34         Sweep Low Temp Recup           36         Sweep Low Temp Recup           37         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Water Separation Tank           46         4           43         Water/Oxygen Seperation           44         SET-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         6           57         8           58         6           59         6           61         6	Heat Exchanger	2 Sweep Gas/O2 Out	4 5	No	500.0 *			
21       M2         22       M3         24       M4         25       M4         26       Recirc         27       Recirc         28       Low Temp Steam/H2 Recu         30       SG1         31       SG1         32       SG2         34       Sweep Low Temp Recup         36       Water Pump         40       Sweep Pump         41       Sweep Pump         42       Sweep Water Recycle Pur         44       Water/Oxygen Seperation Tank         46       Water/Oxygen Seperation         50       RCY-1         51       RCY-2         52       RCY-3         53       SET-1         54       SET-2         55       ADJ-1         56       SU-1         57       Se         59       Se         60       Se         61       Se         62       Sa         63       Sa	Heat Exchanger	22 H2/Steam	6 7	No	500.0 *			
23       M3         24       M4         25       Recirc         27       Recirc         28       Low Temp Steam/H2 Recu         30       SG1         31       SG1         32       SG2         33       SG2         34       Sweep Low Temp Recup         35       Sweep Pump         40       Sweep Pump         41       Sweep Pump         42       Sweep Water Recycle Pur         44       Water Separation Tank         45       Water/Oxygen Seperation         49       RCY-1         51       RCY-2         52       RCY-3         53       SET-1         56       ADJ-1         56       ADJ-1         57       Se         59       60         61       62         63       64	Mixer	3 24	22	No	500.0 *			
25         M4           26         Recirc           27         Recirc           29         Low Temp Steam/H2 Recu           30         SG1           31         SG2           34         Sweep Low Temp Recup           36         Sweep Low Temp Recup           37         Water Recycle Pump           40         Sweep Pump           41         Sweep Water Recycle Pur           42         Sweep Water Recycle Pur           43         Sweep Water Recycle Pur           44         Water/Oxygen Seperation Tank           45         Water/Oxygen Seperation           47         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         60           61         62           63         63           64         63	Mixer	32 41	30	No	500.0 *			
27         Recirc           28         Low Temp Steam/H2 Recu           30         SG1           31         SG2           33         SG2           34         Sweep Low Temp Recup           36         Water Pump           39         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           43         Sweep Rump           44         Water/Oxygen Seperation Tank           46         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         Sadd           59         Sadd           61         Sadd           62         Sadd           63         Sadd	Mixer	13 8	15	No	500.0 *			
29         Low Temp Steam/H2 Recu           30         SG1           31         SG2           33         SG2           34         Sweep Low Temp Recup           36         Water Pump           39         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           43         Sweep Water Recycle Pur           44         Water/Oxygen Seperation Tank           46         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         SET           59         Set           60         Set           61         Set           62         Set           63         Set	Compressor	Hydrogen Recycle Recirc Power	37	No	500.0 *			
31         SG1           32         SG2           33         SG2           34         Sweep Low Temp Recup           35         Sweep Low Temp Recup           36         Water Pump           39         Water Recycle Pump           40         Sweep Pump           41         Sweep Water Recycle Pur           42         Sweep Water Recycle Pur           44         Water Separation Tank           46         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         SET           59         60           61         83           63         63           64         53	p LNG	30 7	25 31	No	500.0 *			
32         33           33         SG2           34         Sweep Low Temp Recup           36         Water Pump           37         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           43         Sweep Water Recycle Pur           44         Water Separation Tank           46         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         60           61         83           62         83           63         84	LNG	From Reactor 1 9	26 2	No	500.0 *			
35         Sweep Low Temp Recup           36         Water Pump           37         Water Recycle Pump           40         Sweep Pump           41         Sweep Water Recycle Pur           42         Sweep Water Recycle Pur           43         Sweep Water Recycle Pur           44         Water Separation Tank           46         Water/Oxygen Seperation           47         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         S           59         S           60         8           61         8           62         8           63         8           64         8	LNG	25 From Reactor 2	3 27	No	500.0 *			
36         Water Pump           37         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           44         Water Separation Tank           46         Water/Oxygen Seperation           49         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         1           61         8           62         8           63         8           64         8	LNG	15 5	9 10	No	500.0 *			
38         Water Recycle Pump           40         Sweep Pump           41         Sweep Pump           42         Sweep Water Recycle Pur           43         Water Separation Tank           46         44           45         Water/Oxygen Seperation           46         6           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         64	Pump	Water In Water Pump Power	32	No	500.0 *			
40         Sweep Pump           41         Sweep Water Recycle Pur           42         Sweep Water Recycle Pur           44         Water Separation Tank           46         47           48         Water/Oxygen Seperation           49         50           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         60           61         62           63         64	Pump	38 Water Recycle Pump Pow	40	No	500.0 *			
42         Sweep Water Recycle Pur           43         Sweep Water Recycle Pur           44         Water Separation Tank           46         Water Separation Tank           47         Water/Oxygen Seperation           49         RCY-1           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-1           55         ADJ-1           56         57           58         59           60         61           62         63           64         Set August Au	Pump	Sweep Water In Sweep Pump Power	8	No	500.0 *			
44         Water Separation Tank           46         46           47         48           48         Water/Oxygen Seperation           49         50           50         RCY-1           51         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         57	nr Pump	12 Swp Rcy Pmp Pwr	11	No	500.0 *			
46           47           48           49           50           RCY-1           51           RCY-2           52           RCY-3           53           SET-1           54           55           ADJ-1           56           57           58           59           80           61           62           63		31	38					
47         Water/Oxygen Seperation           49         50         RCY-1           51         RCY-2         52           52         RCY-3         53           53         SET-1         54           54         SET-2         55           55         ADJ-1         56           59         60         61           61         62         63           64         64         64	Separator	Ambient Cooling	35 Ambient Cooling	No	500.0 *			
61         RCY-2           52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         64	Ti Separator	10 Ambient Cooling 2	12 Oxygen Product Ambient Cooling 2	No	500.0 *			
52         RCY-3           53         SET-1           54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         64	Recycle	37	24	No	3500 *			
53         SET-1           54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         64	Recycle	40	41	No	3500 *			
54         SET-2           55         ADJ-1           56         57           58         59           60         61           62         63           64         64	Recycle Set	11	13	No	3500 * 500.0 *			
55 ADJ-1 56 57 58 59 80 81 62 63 84	Set			No No	500.0 *			
56 57 58 59 60 61 62 63 63	Adjust			No	3500 *			
65								
					_			
66 Hyprotech Ltd. Licensed to: INL		HYSYS.Plant v2.2.2 (Build	d 3806)		Page 5 of 14 * Specified by user.			

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1	No.					Case Name: C	:\Documents and Setti	ngs\mgq\D	esktop\NGNF	VFY 09 Report\600 MV
3	-	-	INL Calgary, A	Nherta		Unit Set: N	IGNP1			
4	HY	PROTECH	CANADA	hiberta						
5	per la					Date/Time: T	Thu Oct 01 11:50:20 20	09		
6			_							
7		Workb	ook:	High Ten	npe	erature Ele	ctrolysis (1	[PL1]		
8				-	-			•		
9 10						Streams				
10	Name			Process In @TP	11	Sweep Gas In @TPL	Cathode @TPL1	Sween	Gas/O2 Out (	Gas Products @TPL
12	Vapour F	Fraction		1.00		1.0000	1.0000	Oweep	1.0000	1.0000
13	Tempera		(C)	800.		800.00	800.00 *		800.00	800.00
14	Pressure		(MPa)	5.00		5.0000	5.0000		5.0000	5.0000
15	Molar Flo	l) wc	kgmole/h)	5169	9.3	1551.2	5169.3		3101.9	6720.1
16	Mass Flo	ow	(kg/s)	23.5	71	7.7631	9.7869		21.547	23.571
17	Liquid Vo	olume Flow	(m3/h)	98.	90	28.00	132.4		71.62	176.0
18	Heat Flo		(kW)	-2.712e+0		-9.151e+004	-6.830e+004		053e+004	-5.739e+004
19	Molar En	thalpy (k	J/kgmole)	-1.888e+0		-2.124e+005	-4.757e+004		346e+004	-3.075e+004
20	Name	Fraction		Liquid Products (		Anode @TPL1	Molar Flow of Oxyger	Electroly	sis Heating (	Electrode Heat @TPI
21 22	Vapour F Tempera		(C)	0.00		1.0000 804.96				
22	Pressure		(MPa)	5.00		5.0000				
23	Molar Flo		(IVIFa) kgmole/h)	0.000		1550.7	1550.7	ļ		
25	Mass Flo		(kg/s)	0.000		13.784	13.784			
26		olume Flow	(m3/h)	0.00	00	43.62	43.62			
27	Heat Flo	w	(kW)	0.00		1.098e+004		2.	138e+005	71.04
28	Molar En	nthalpy (k.	J/kgmole)	-2.975e+0	04	2.549e+004				
29	Name			Process Heat @	TPL	Electrolysis Power @				
30	Vapour F									
31	Tempera		(C)							
32	Pressure		(MPa)							
33	Molar Flo	,	kgmole/h)							
34 35	Mass Flo	olume Flow	(kg/s)							
36	Heat Flo		(m3/h) (kW)	-4.865e-0		-2.138e+005				
37	Molar En		J/kgmole)			-2.1386+003				
38			g)							
39						Unit Ops				
40	Оре	eration Name	Ope	eration Type		Feeds	Products		Ignored	Calc. Level
41					Proc	ess In @TPL1	Liquid Products @	TPL1		
42	Isotherm	al Electrolysis @TP	Conversi	on Reactor	Elec	trolysis Heating @TPI	-		No	500.0 *
43							Electrolysis Heatir			
44	MIX 100	OTD 4	N.4			id Products @TPL1	Sweep Gas/O2 Ou	ut @TPL1		
45 46	MIX-100	WIFLI	Mixer			le @TPL1			No	500.0 *
40 47					Sweep Gas In @TPL1 Gas Products @TPL1		Cathode @TPL1			
48	Electrode	es @TPL1	Compone	ent Splitter		trode Heat @TPL1	Anode @TPL1		No	500.0 *
49	Gas Pro	duct Temperature @	Set						No	500.0 *
50		emperature @TPL1	Set						No	500.0 *
51	Outlet Pr	ressure @TPL1	Set					_	No	500.0 *
52		nperature @TPL1	Set						No	500.0 *
53		nperature Electrolys							No	500.0 *
54		erage ASR @TPL1	Spreadsh	neet			_		No	500.0 *
55 56	ADJ-1@		Adjust						No	3500 *
56 57	ADJ-2@	yırLI	Adjust						No	3500 *
58		Sprea	deho	ot High .	Ton	noraturo	Electrolysi	ം ത	DI 1 Unit	s Set: Electrolysis
59		opiea	dane	ct. mgn	I CII	perature	LICCUOIYSI			Cool. Licetrolysis
60							<b>`</b>			
61						CONNECTIONS	<b>5</b>			
62					1-	nnorted Variabl	00			
63						nported Variabl	63			
64	Cell		Object				riable Description			Value
65	D2	Material Strea	m: Proce	ss In @TPL1		erature				1073.1 K
66	Hyprote Licensed to:				HISI	'S.Plant v2.2.2 (Build	13806)			Page 6 of 14 * Specified by user.
	LICENSED TO:	INL								Specified by User.

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1			Case Name: C:\Documents and S	ettings\mgq\Desktop\N	GNP\FY 09 Report\600 MV		
3	HY	INL Calgary, Alberta	Unit Set: NGNP1	Unit Set: NGNP1			
4 5	in the second se	CANADA	Date/Time: Thu Oct 01 11:50:20	2009			
6							
7		Spreadsheet: High	Temperature Electrolys	SIS @IPL1	Units Set: Electrolysis		
9			CONNECTIONS				
10 11			Imported Variables				
12 13	Cell	Object	Variable Description		Value		
14	D3	Material Stream: Cathode @TPL1	Temperature		1073.2 K		
15	A8	Material Stream: Process In @TPL1	Pressure		5.0000e+006 N/m2		
16	E2	Material Stream: Process In @TPL1	Comp Mole Frac (H2O)		0.90000		
17	F2	Material Stream: Process In @TPL1	Comp Mole Frac (Hydrogen)		0.10000		
18	G2	Material Stream: Sweep Gas In @TPL1	Comp Mole Frac (Oxygen)		0.00014		
19	E3	Material Stream: Cathode @TPL1	Comp Mole Frac (H2O)		0.30000		
20	F3	Material Stream: Cathode @TPL1	Comp Mole Frac (Hydrogen)		0.70000		
21	G3	Material Stream: Sweep Gas/O2 Out @TF	Comp Mole Frac (Oxygen)		0.50000		
22 23	B11 B12	SpreadSheetCell: Electrolysis Input and O	B2: Number of Cells		1.057e+006		
23 24	B12 B13	SpreadSheetCell: Electrolysis Input and O SpreadSheetCell: Electrolysis Input and O	B3: Cell Area B4: Current Density (Amperes/cm <sup>2</sup> )		225.0 cm2 0.6989		
24 25	B13 B16	SpreadSheetCell: Electrolysis input and O SpreadSheetCell: Temp Average ASR@B2	B4: Current Density (Amperes/cm*2) B2: Temp Aver ASR		0.4000		
26	D11	Energy Stream: Electrolysis Heating @T	Heat Flow		2.138e+005 kW		
20	D12	Energy Stream: Electrodysis reading @Th Energy Stream: Electrode Heat @TPL1	Heat Flow		71.04 kW		
28	012				71.011		
29		Expo	rted Variables' Formula Results				
30	Cell	Object	Variable Description		Value		
31	B15	Molar Flow of Oxygen @TPL1	Molar Flow		430.75 gmole/s		
32	B19	Electrolysis Power @TPL1	Power	-2.138e+005 kW			
33 34	B20	Process Heat @TPL1	Heat Flow		-4.865e-005 kW		
35			PARAMETERS				
36							
37			Exportable Variables				
38	Cell	Visible Name	Variable Description	Variable Type	Value		
39	A1	A1: A1 for Gibbs Formation Energy	A1 for Gibbs Formation Energy	Gibbs. Coeff. CA	2.382e+005 J/gmole		
40	A2	A2: A2 for Gibbs Formation Energy	A2 for Gibbs Formation Energy	Gibbs. Coeff. CB	39.95 J/gmole-K		
41	A3	A3: A3 for Gibbs Formation Energy	A3 for Gibbs Formation Energy	Gibbs. Coeff. CC	3.319e-003 kJ/gmol-K		
42	A4	A4: A4 for Gibbs Formation Energy (kJ/gmol-K*	A4 for Gibbs Formation Energy (kJ/gmol-K^3)		-3.532e-008		
43	A5	A5: A5 for Gibbs Formation Energy	A5 for Gibbs Formation Energy	Gibbs. Coeff. CB	-12.85 J/gmole-K		
44	A6	A6: Fa Faraday Number (J/Volt-gmole)	Fa Faraday Number (J/Volt-gmole)		9.649e+004		
45 46	A7	A7: R Universal Gas Constant	R Universal Gas Constant	Entropy	8.314 J/gmole-K		
46 47	A9 B14	A9: Standard Pressure B14:	Standard Pressure	Pressure	1.0132e+005 N/m2		
47 48	B14 B15	B14: B15: Molar Flow	Molar Flow	 Flow	157.2 430.75 gmole/s		
40 49	B15 B17	B17:	WORT FOW	Vapour Fraction	1.0067		
49 50	B17 B18	B17. B18:		Vapour Fraction	1.2862		
51	B19	B19: Power	Power	Power	-2.138e+005 kW		
52	B20	B20: Heat Flow	Heat Flow	Energy	-4.865e-005 kW		
53	D4	D4:		Temperature	-1.3642e-012 K		
54	D6	D6:		Temperature	1073.1 K		
55	D8	D8:			3.501e-007		
56	D9	D9:			2.567e+005		
57	E4	E4:		Vapour Fraction	-0.6000		
58	E5	E5:		Vapour Fraction	0.3336		
59	F4	F4:		Vapour Fraction	0.6000		
60	F5	F5:		Vapour Fraction	-0.6194		
61	G4	G4:		Vapour Fraction	0.4999		
	G5	G5:		Vapour Fraction	-0.8452		
62		H2:			6.875e-003		
62 63	H2	L12.					
62 63 64	H3	H3:			24.67		
62 63		H4:	HYSYS.Plant v2.2.2 (Build 3806)		24.67 24.67 Page 7 of 14		

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1			Case Name	: C:\Documents and S	Settings\mgq\Desktop\NG	NP\FY 09 Report\600 MV
3	H	INL Calgary, Alberta	Unit Set:	NGNP1		
4	No.	CANADA	Date/Time:	Date/Time: Thu Oct 01 11:50:20 2009		
6						
7		Spreadsheet: High T	emperatu	re Electroly	sis @TPL1 ပ	Jnits Set: Electrolysis
9 10			PARAMET	ERS		
11 12			Exportable Va	ariables		
13	Cell	Visible Name	Variable	Description	Variable Type	Value
14	H5	H5:		·		54.46
15	12	12:			Molar Enthalpy	1.887e+005 J/gmole
16	13	13:			Molar Enthalpy	1.887e+005 J/gmole
17	16	16:			Molar Enthalpy	1.887e+005 J/gmole
18	J2	J2:			Entropy	2.321e+008 J/gmole-k
19	J3	J3:			Entropy	2.321e+008 J/gmole-k
20	K2	K2:				0.7610
21	K3	K3:				1.091
22	K6	К6:			Vapour Fraction	1.0067
23	K7	К7:				0.9333
24			User Varia	bles	1	1
25 26			FORMUL			
27 28	Cell		Formula	A0		Result
29	B14	=B12*B13	. ormana			157.2
30	B15	=B11*B14/(4*A6)				430.75 gmole/s
31	B17	@IF(@ABS(D4)<1e-3,K6,K7)				1.0067
32	B18	=B17+B13*B16				1.2862
33	B19	=-B11*B18*B14/1000				-2.138e+005 kW
34	B20	=B19+D11+D12				-4.865e-005 kW
35	D20	=D2-D3				-1.3642e-012 K
36	D6	=(D2+D3)/2				1073.1 K
37	D8	=1/(2*A6*H4*F4)				3.501e-007
38	D0	=-1/(2*A6*H4*F4*D4)				2.567e+005
39	E4	=E3-E2				-0.6000
40	E5					0.3336
40	 F4	=(E3*@LN(E3)-E3) - (E2*@LN(E2)-E2) =F3-F2				0.6000
41	F5					
42	 G4	=(F3*@LN(F3)-F3) - (F2*@LN(F2)-F2) =G3-G2				-0.6194
43 44	G5					0.4999
44 45		=(G3*@LN(G3)-G3) - (G2*@LN(G2)-G2)				-0.8452
45 46	H2	=G2*A8/A9				6.875e-003
46 47	H3	=G3*A8/A9				24.67
47 48	H4	=H3-H2				24.67
	H5	=(H3*@LN(H3)-H3) - (H2*@LN(H2)-H2)	(D2)			54.46
49	12	=A1 + A2*D2+ A3*D2*2 + A4*D2*3 + A5*D2*@LN				1.887e+005 J/gmole
50	13	=A1 + A2*D3+ A3*D3^2 + A4*D3^3 + A5*D3*@LN				1.887e+005 J/gmole
51	16	=A1 + A2*D6+ A3*D6*2 + A4*D6*3 + A5*D6*@LN		2) 0 5)		1.887e+005 J/gmole
52 53	J2	$= A1^{*}D2 + A2/2^{*}D2^{*}2 + A3/3^{*}D2^{*}3 + A4/4^{*}D2^{*}4 + A3/3^{*}D2^{*}2 + A3/3^{*}D2^{*}2 + A3/3^{*}D2^{*}4 + A3/3^{*}4 + A3/3^{*}4 + A3/3^{*}4 + A3/3^{*}4 + A3/3^{*}4 + A3/3^{*}4$				2.321e+008 J/gmole-k
	J3 = A1*D3 + A2/2*D3^2 + A3/3*D3^3 + A4/4*D3^4 + A5/2*D3^2*(@LN(D3)-0.5)				2.321e+008 J/gmole-k	
54 55	$\frac{K2}{K2} = \frac{1}{(2^*A6)^*(12-A7^*D2^*@LN(E2/(F2^*H2^*0.5)))}$				0.7610	
_				1.091		
56 57						1.0067
57 58	K7	=D9*(A7/2*(D3*2-D2*2)*((E5+F5)*H4 + H5/2*F4)		voot		0.9333
59 60		AB	Spreadsh C	D	E	F
60 61	1	2.382e+005 J/gmole * \$ibbs Formation Energy *	~	Temperature *	y H2O *	<b>⊢</b> h H2 *
62	2	39.95 J/gmole-K * \$ibbs Formation Energy *	in *	1073.1 K	0.90000	0.10000
62 63		19e-003 kJ/gmol-K <sup>2</sup> sibbs Formation Energy *	out *	1073.1 K 1073.2 K *	0.30000	0.10000
63 64	<u> </u>	-3.532e-008 * in Energy (kJ/gmol-K^3) *	Delta *	-1.3642e-012 K	-0.6000	0.70000
65	5	-3.532e-008 in Energy (kJ/gmol-K^3) - -12.85 J/gmole-K * \$ibbs Formation Energy *	Integration Coeff *	-1.30428-012 K	0.3336	-0.6194
66			HYSYS.Plant v2.2.2	(Build 3806)	0.3330	Page 8 of 14
50	Licensed		THOTO, FIGHT VZ.Z.Z	(Dalid 3000)		* Specified by user.

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1	1			Case Nam	e: C:\Documents and S	Settings\mgq\Desktop\N	IGNP\FY 09	Report\600 MV
3			Unit Set:	NGNP1				
4 5		•	CANADA	Date/Time	: Thu Oct 01 11:50:20	0 2009		
6		•		- (				
7 8		Spread	dsheet: High	Temperati	ire Electroly		Units Set:	Electrolysis
9 10				Spreads	heet			
11	6	9.649e+004 *	Number (J/Volt-gmole) *	A∨erage *	1073.1 K			
12	7		Jni∨ersal Gas Constant *	0: 11 11	0.504.007			
13 14	8 9	5.0000e+006 N/m2 1.0132e+005 N/m2 *	Pressure * Standard Pressure *	C isothermal * C a∨erage *	3.501e-007 2.567e+005			
15	10	1.01020100014112		e average	2.0070.000			
16	11	Number of Cells *	1.057e+006 *	Electrolysis Heating *	2.138e+005 kW			
17	12	Cell Area *	225.0 cm2 *	Electrode Heat *	71.04 kW			
18 19	13 14	ensity (Amperes/cm^2) * Current (Amperes) *	0.6989 * 157.2					
20	15	Molar Flow of Oxygen *	430.75 gmole/s					
21		Resistance (ohm*cm^2) *	0.4000 *					
22		Nernst Potential (Volts) *	1.0067					
23		perating Voltage (Volts) *	1.2862				_	
24 25	19 20	Electrolysis Power * Process Heat *	-2.138e+005 kW -4.865e-005 kW					
26	20	G	-4.8056-005 KW		J	К		
27	1	y 02 *	y A *	Delta G *	Integral Delta G dT *	Nernst Voltage	*	
28	2	0.00014	6.875e-003	1.887e+005 J/gmole	2.321e+008 J/gmole-K	0.7610		
29	3	0.50000	24.67	1.887e+005 J/gmole	2.321e+008 J/gmole-K	1.091		
30	4	0.4999	24.67					
31 32	5	-0.8452	54.46	1.007-:005	la séla sursal t	1 0067		
33	6 7			1.887e+005 J/gmole	Isothermal * Average *	1.0067		
34	8				Avelage	0.8555		
34 35	9							
36	10							
37	11							
38 39	12 13							
	14							
40 41	15							
42	16							
43	17							
44	18							
45 46	19 20							
40	20							
48		Sprea	dsheet: Tem	p Average /	ASR @TPL1		Units Set:	Electrolysis
49 50		•			<u> </u>			
51				CONNECT	TIONS			
52 53	Imported Variables							
54	Ce	Cell Object Variable Description Value		/alue				
55	B1		II: Electrolysis Input and O		(ohms*cm*2)		0.2776	
56	A3		n: Process In @TPL1	Temperature			1073.1	
57 58	E1							
59		Exported Variables' Formula Results						
60	Cell Object Variable Description Value							
61								
62 63								
64								
65								
66		rotech Ltd.		HYSYS.Plant v2.2.2	2 (Build 3806)			age 9 of 14
_	Licensed to: INL * Specified by user.							

Identifier:	TEV-693	
Revision:	1	
Effective Date:	05/15/10	Page: 122 of 151

Init Set:         NOMP1           Date:Time:         NOMP1           Date:Time:         Trude 01 11 50 2000           Spreadsheet: Temp Average ASR @TPL1 (continue( unit set:         team           Date:Time:         Team           Date:Time:         Team           Texportable Variable Sectorption         Value           Colspan="2">Value           Temperature         Torporture         Torporture         Value           Colspan="2">Value           Add A4         Temperature         Value           Add A4         Temperature         Value           Add A4         Temperature         Value           Add A4         Add A4           Add A4         Value           Add A4         Value           Value         Value           Add A4         Value           Value         Value           Value         Value         Value	1		INI	Case Name:	C:\Documents and	Settings\mgq\Desktop\N	IGNP\FY 09 Report\600 M\
Cate/Time         Thu Cxt 01 11 50 20 2009           SpreadSheet: Temp Average ASR @TPL1 (Continue( Units Set Excited Set	3	HY	Calgary, Alberta	Unit Set:	NGNP1		
Image: Spreadsheet: Temp Average ASR @TPL1 (continue: Units Set: Electrol)           PARAMETERS           Exportable Variables           Colspan="2">Value           Variable Variables           Variable Variable Type         Value	_		CANADA	Date/Time:	Thu Oct 01 11:50:2	0 2009	
Image: Section of the sectio	6						
Description         PARAMETRY           12	-		Spreadsheet: Temp	Average AS	R @TPL1	(continued	Units Set: Electrolysis
International System         Exportable Variables           10         Cell         Variable Name         Variable Description         Variable Type         Variable Type           16         A6         A6:         Temperature         1073.1 K           17         A7         A7         A7         A7         A7           19         A8         A8         Temperature         1073.1 K           19         A7         A7         A7         Temperature         1073.1 K           10         A8         A8         Temperature         1073.1 K           10         A9         A8:         Temperature         1073.1 K           11         A10         Temperature         1073.1 K           12         A12         Temperature         1073.1 K           13         A13         A13         A13         A14         Temperature         1073.1 K           14         A14         Temperature         1073.1 K         Temperature         1073.1 K           14         A16         Temperature         1073.1 K         Temperature         1073.1 K           14         A16         Temperature         1073.1 K         Temperature         1073.1 K				PARAMETER	S		
I         Cell         Variable Name         Variable Description         Variable Type         Value           11         Ad         Ad:         Ad:         Temperature         1073.1 K           12         Ad         Ad:         Temperature         1073.1 K           12         Ad         Ad:         Temperature         1073.1 K           12         Ad         Ad:         Temperature         1073.1 K           13         Ad         Ad:         Temperature         1073.1 K           14         Ad         Ad:         Temperature         1073.1 K           15         Ad         Ad:         Temperature         1073.1 K           16         Ad         Ad:         Temperature         1073.1 K           17         Temperature         1073.1 K         Temperature         1073.1 K           18         Ad:         Ad:         Temperature         1073.1 K           19         Ad:         Ad:         Temperature         1073.1 K           1073.1 K         Temperature         1073.1 K         Temperature         1073.1 K           107         Ad:         Ad:         Ad:         Ad:         Ad:           1073.1 K	11			Exportable Varia	ables		
Instruct         Temperature         1073 1 K           Id         A6         A6:         Temperature         1073 1 K           Id         A6         A6:         Temperature         1073 1 K           Id         A7         A7         Temperature         1073 1 K           Id         A8         A6:         Temperature         1073 1 K           Id         A9         A6:         Temperature         1073 1 K           Id         A9         A6:         Temperature         1073 1 K           Id         A9         A6:         Temperature         1073 1 K           Id         A11         Temperature         1073 1 K         Temperature         1073 1 K           Id         A12         A12         A12         A12         A13         A13:         Temperature         1073 1 K           Id         A16         A16:         Temperature         1073 1 K         Temperature         1073 1 K           Id         A16         A16:         Temperature         1073 1 K         A13           Id         A14	_	Cell	Visible Name			Variable Type	Value
10         A6         A6:         Temperature         1073.1 K           10         A7         A7:         Temperature         1073.1 K           10         A8         A8:         Temperature         1073.1 K           10         A0         Temperature         1073.1 K           11         A10         Temperature         1073.1 K           12         A11         A11         A11         Temperature         1073.1 K           12         A12         A12         A12         Temperature         1073.1 K           12         A14         A12         Temperature         1073.1 K           13         A14         A14         Temperature         1073.1 K           14         A14         A14         Temperature         1073.1 K           15         A14         A14         A14         Temperature         1073.1 K           16         A14         A14         A14         A14         A14         A14         A14         A14         A14         A17         A14         A14 <td>14</td> <td></td> <td></td> <td></td> <td>•</td> <td></td> <td></td>	14				•		
Instruct         AT         <		A5	A5:			Temperature	1073.1 K
18         A8         A8:         A8:         A8:         A8:         Temperature         1073.1 K           19         A10         A00         Temperature         1073.1 K           10         A10         A00         Temperature         1073.1 K           11         A11         A11         Temperature         1073.1 K           12         A12         A12         Temperature         1073.1 K           12         A13         A13         A13         A13         A13           13         A14         A14         Temperature         1073.1 K           14         A14         A14         Temperature         1073.1 K           15         A15         A16         Temperature         1073.1 K           16         A16         Temperature         1073.1 K         Temperature         1073.1 K           17         A17						Temperature	
19         A9         A13         Temperature         1073 I K           21         A13         A12         A12         A12         A12         A13         Temperature         1073 I K           22         A14         A14         A14         A14         Temperature         1073 I K           23         A15         A15         Temperature         1073 I K         Temperature         1073 I K           23         A16         A18         A18         A18         A18         A18         A13         A17         Temperature         1073 I K           24         A19         A17         Temperature         1073 I K         Temperature         1073 I K           24         A19         A16         A18         A18         A18         A18         A19         A17         A17         A17         A17         A17         A17         A17         A17         A18	-						
30         A10         A10         A10         Temperature         1073.1 K           21         A12         A12         Temperature         1073.1 K           21         A12         Temperature         1073.1 K           21         A13         A13         A13         Temperature         1073.1 K           21         A14         A14         Temperature         1073.1 K           25         A15         A16         Temperature         1073.1 K           26         A16         Temperature         1073.1 K           27         A17         A17         A17         A17           28         A18         A18         Temperature         1073.1 K           29         A19         A19         A19         A19         A19         A19           29         A19         A19         A19         A19         A10         Temperature         1073.1 K           29         A19         A19         A19         A19         A19         A10         Temperature         1073.1 K           20         A20         A20         A20         A20         A20         A20         A20         A20         A20         A20 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>							
21       A11       A11:       A11:       A11:       Temperature       1073.1 K         22       A12       A12:       Temperature       1073.1 K         23       A13       A13:       Temperature       1073.1 K         24       A14       A14:       Temperature       1073.1 K         25       A15       A15:       Temperature       1073.1 K         26       A16       A16:       Temperature       1073.1 K         27       A17       A17:       Temperature       1073.1 K         28       A18       A18:       A18:       Temperature       1073.1 K         29       A14       A18:       A19:       Temperature       1073.1 K         29       A19       A19:       Temperature       1073.1 K         20       A20       A20       A20       A20       A20       A20         31       B4       B4:        0.4000       A19:         32       B4       B4:        0.4000         33       B4       B4:        0.4000         34       B5       B5:        0.4000         35       B6							
22         A12         A12         A12         A12         A12         A12         A12         A13         A13         A14         Temperature         1073.1 K           21         A14         A14         A14         Temperature         1073.1 K           25         A15         A15         A16         Temperature         1073.1 K           25         A16         A16         Temperature         1073.1 K           27         A17         A17         A17         A17         A17           21         A13         A18         Temperature         1073.1 K           22         A20         Temperature         1073.1 K         Temperature         1073.1 K           23         A39         A19         A18         Temperature         1073.1 K           24         A20         Temperature         1073.1 K         Temperature         1073.1 K           25         B2         B2.1 Temp Aver ASR         Temperature         0.4000         Temperature         1073.1 K           26         B3         B3         B3         Temp Aver ASR         Temperature         0.4000           27         B4         B4         H1         Temperature         <	-						
23         A13         A13:         A14:         Temperature         1073.1 K           23         A15         A15:         Temperature         1073.1 K           23         A16         A16:         Temperature         1073.1 K           24         A16         A16:         Temperature         1073.1 K           25         A17         Temperature         1073.1 K         Temperature         1073.1 K           25         A17         A17         Temperature         1073.1 K         Temperature         1073.1 K           26         A19         A19:         Temperature         1073.1 K         0.4000           26         A20         A20:         A20         A20:         A20         A20:         A400	_						
2x         At4         At4:         At4:         Importance         1073.1 K           29         At5         At5:         Temperature         1073.1 K           27         At7         At7:         Temperature         1073.1 K           27         At7         At7:         Temperature         1073.1 K           28         At8         Temperature         1073.1 K           29         At9         At9         At9         At9           4         At9         At9         At9         At9           9         A20          40.00           28         B3         B3         B4          0.4000           29         B5         B5:          0.4000           29         B6         B6:          0.4000           29         B7         B7:          0.4000           29         B7         B7:          0.4000           20         B7         B7:          0.4000           30         B10         B10:          0.4000           31         B41         B14:          0.							
29         A15         A15         A15         A15         A15         A16         A17         Temperature         1073.1 K           20         A17         A17         Temperature         1073.1 K         Temperature         1073.1 K           20         A18         A18         A18         Temperature         1073.1 K           20         A20         A20         A20         Control         Temperature         0.4000           21         B3         B3.          0.4000         0.4000           21         B3         B3.          0.4000           23         B4         B4:          0.4000           24         B5         B5:          0.4000           25         B6         B6:          0.4000           26         B7         B7          0.4000           27         B8         B8:         B8:          0.4000           28         B7         B7          0.4000           29         B18         B10:          0.4000           20         B10         B10:							
20         A16         A16:         Temperature         1073.1 K           21         A17         A17.         A17.         A17.         Temperature         1073.1 K           21         A18         A18.         Temperature         1073.1 K           23         A18         A18.         Temperature         1073.1 K           20         A19         A19.         A19.         A19.         A19.           21         B3         B4.         A20.          0.4000           21         B3         B3.          0.4000           23         B4         B4:          0.4000           24         B5         B5:          0.4000           25         B6         B6:          0.4000           26         B7         B7:          0.4000           27         B8         B8:          0.4000           28         B6         B6:          0.4000           29         B10         B10:          0.4000           29         B12         B12:         B12:         B14:	_						
27       A17       A17       A17       A17       A17       A17       A17       A17       A18       Temperature       1073.1 K         20       A18       A18       Temperature       1073.1 K       1073.1 K         20       A19       A19       Temperature       1073.1 K       1073.1 K         21       A20       A20       A20       A20       A000	_						
20         A18         A18:         Comparature         1073.1 K           21         A19         A19:         Temperature         1073.1 K           23         A20							
22         A19         A19:         Component of the section	_						
420         A20:         A20:          40.00           11         B2:         Temp Aver ASR          0.4000           13         B3:         B3:          0.4000           13         B4:         B4:          0.4000           13:         B4:         B4:          0.4000           13:         B4:         B4:          0.4000           13:         B4:         B4:          0.4000           13:         B5:          0.4000          0.4000           14:         B1:          0.4000          0.4000           15:         B10:          0.4000          0.4000           15:         B12:         B12:         B12:          0.4000           16:         B14:	-						
B3         B3:         B3:          0.4000           33         B4         B4:          0.4000           34         B5         B5:          0.4000           35         B6         B6:          0.4000           36         B7         B7:          0.4000           37         B8         B8:          0.4000           38         B9         B9:          0.4000           39         B10         B10:          0.4000           41         B11:          0.4000           42         B13         B12:          0.4000           43         B12         B12:          0.4000           44         B14:         B14:          0.4000           45         B16         B16:          0.4000           46         B15         B16:          0.4000           47         B18         B18:          0.4000           48         B19         B19:          0.4000           40	_					· ·	
B4         B4:          0.4000           34         B5         B6:          0.4000           35         B6         B6:          0.4000           36         B7         B7:          0.4000           37         B8         B8:          0.4000           38         B8:          0.4000           39         B9         B9:          0.4000           30         B10         B10:          0.4000           40         B11         B11:          0.4000           41         B12         E12:          0.4000           42         B13         B13:          0.4000           43         B14         B14:         E12:          0.4000           44         B15         B15:          0.4000           44         B15         B16:          0.4000           45         B16         B16:          0.4000           46         B19         B19:          0.4000           51         C2<	31	B2	B2: Temp Aver ASR	Temp Aver ASR			0.4000
24         B5         B5:          0.4000           25         B6         B6:          0.4000           26         B7          0.4000           27         B8         B8:          0.4000           28         B8         B8:          0.4000           28         B9         B9:          0.4000           20         B10          0.4000           40         B11         B11:          0.4000           41         B12         B12:          0.4000           42         B13         B13:          0.4000           43         B14         B14:          0.4000           44         B14:          0.4000           45         B16         B16:          0.4000           46         B17         B17:          0.4000           47         B18         B18:         B18:         B18:         B18:         B18:         B19:          0.4000           45         C2         C2:         C2:         C3	32	B3	B3:				0.4000
B6         B6:          0.4000           B7         B7:          0.4000           B8         B8:          0.4000           B9         B9:          0.4000           B10         B10:          0.4000           B11         B11:          0.4000           B12         B12:          0.4000           B13         B13:          0.4000           44         B14:          0.4000           45         B14         B14:          0.4000           46         B17         B17:          0.4000           47         B18         B18:         B16:          0.4000           48         B14         B14:          0.4000           49         B16         B16:          0.4000           40         B17         B17:          0.4000           41         B18         B18:         B18:         B18:         B19         B19:          0.4000           51         C2         C2:         C2:	33	B4	B4:				0.4000
20         B7         B7:          0.4000           37         B8         B8:          0.4000           38         B9         B8:          0.4000           38         B10         B10:          0.4000           38         B10         B10:          0.4000           40         B11         B11:          0.4000           40         B12         B12:         B12:         0.4000           41         B12         B12:          0.4000           42         B13         B13:          0.4000           43         B14         B14:         B16:          0.4000           44         B15         B16:          0.4000           45         B16         B16:          0.4000           46         B19         B19:          0.4000           47         B18         B18:         B18:         B18:         B18:         B18:           51         C2         C2:         C2:          19.20           52         C3		B5	B5:				0.4000
31       B8       B8:        0.4000         33       B9       B9:        0.4000         34       B10        0.4000         35       B10       B10:        0.4000         36       B11       B11:        0.4000         41       B12       B12:        0.4000         42       B13       B13:        0.4000         43       B14       B14:        0.4000         44       B15       B15:        0.4000         44       B16       B16:        0.4000         45       B14       B17:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3 <t< td=""><td></td><td>B6</td><td>B6:</td><td></td><td></td><td></td><td>0.4000</td></t<>		B6	B6:				0.4000
B9         B9:          0.4000           38         B10         B10;          0.4000           41         B11:          0.4000           41         B12         B12;          0.4000           42         B13         B13;          0.4000           43         B14         B14;          0.4000           44         B15          0.4000           45         B16         B16;          0.4000           46         B15         B15;          0.4000           47         B18         B18;          0.4000           48         B19         B19;          0.4000           49         B20         B20;          0.4000           49         B20         B20;          0.4000           40         C1         C1:         Temperature         1073.1 K           52         C3         C3;         C3;         Temperature         1073.1 K           52         C4         C4:         Temperature         1073.1 K           53	_						
38         B10         B10:          0.4000           40         B11         B11:          0.4000           41         B12         B12:          0.4000           42         B13         B13:          0.4000           43         B14         B14:          0.4000           44         B15         B15:          0.4000           45         B16         B16:          0.4000           46         B17         B17:          0.4000           47         B18         B18:          0.4000           48         B19         B19:          0.4000           49         B20         B20:          0.4000           49         B20         B20:          0.4000           40         C2         C2:         C2:          0.4000           41         C4:          0.4000            52         C4         C4:          0.4000           43         B20:         S20:         S20:							
40       B11       B11:        0.4000         41       B12       B13:        0.4000         42       B13       B13:        0.4000         42       B13       B13:        0.4000         42       B13       B13:        0.4000         43       B14       B14:        0.4000         44       B15       B15:        0.4000         45       B16        0.4000          46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        0.4000         40       B20       B20:        19.20         51       C1       C1:       Temperature       1073.1 K         52       C3       C3:       C3:       C3:       C3:         54       C4:       Temperature       1073.1 K       C4         55       C6       C6:       C6:       Temperature       1073.1 K	-						
41       B12       B12:        0.4000         42       B13       B13:        0.4000         43       B14:        0.4000         44       B15        0.4000         45       B16       B16:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B19       B19:        0.4000         40       B18       B18:        0.4000         41       B19       B19:        0.4000         42       B20       B20:        0.4000         43       B19       B19:        0.4000         44       B20       B20:        0.4000         45       C1       C1:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       C4:       Temperature       1073.1 K         54       C5 </td <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	_						
42       B13       B13:        0.4000         43       B14       B14:        0.4000         44       B15       B15:        0.4000         45       B16       B16:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        0.4000         40       B20       B20:        0.4000         41       B19       B19:        0.4000         42       B20       B20:        0.4000         43       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       C3:       C4       C4:         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K	_						
43       B14       B14:        0.4000         44       B15       B15:        0.4000         45       B16       B16:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        0.4000         49       B20       B20:        0.4000         49       B20       B20:        0.4000         40       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C6       C6:       Temperature       1073.1 K         57       C8       C8:       C9       C9:       Temperature </td <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	_						
44       B15       B15:        0.4000         45       B16       B16:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       C2:       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       C4:       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         56       C9       C9:       C3:       C3:       Temperature       1073.1 K         56       C9       C9:       Temperature       1073.1 K       Temperature       1073.1 K         57       C8       C8:       C8:       Temperature       1073.1 K	-						
45       B16       B16:        0.4000         46       B17       B17:        0.4000         47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       C5:       C5:       C5:         55       C6:       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         50       C11							
46         B17         B17:          0.4000           47         B18         B18:          0.4000           48         B19         B19:          0.4000           49         B20         B20:          0.4000           40         B20         B20:          19.20           50         C1         C1:         Temperature         1073.1 K           51         C2         C2:         Temperature         1073.1 K           52         C3         C3:         Temperature         1073.1 K           52         C3         C3:         Temperature         1073.1 K           53         C4         C4:         Temperature         1073.1 K           54         C5         C5:         Temperature         1073.1 K           55         C6         C6:         Temperature         1073.1 K           56         C7         C7:         Temperature         1073.1 K           57         C8         C8:         Temperature         1073.1 K           58         C9         C9:         Temperature         1073.1 K           59         C10 <t< td=""><td>_</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	_						
47       B18       B18:        0.4000         48       B19       B19:        0.4000         49       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         58       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         50       C10       C11:       T1:       T1:       T1:         50       C10	_						
48       B19       B19:        0.4000         49       B20       B20:        19.20         50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         50       C11       C11:       C11:       Temperature       1073.1 K         50       C10       C10:       Temperature       1073.1 K         51       C11       C11:       Temperature       1073.1 K         52							
49         B20         B20:          19.20           50         C1         C1:         Temperature         1073.1 K           51         C2         C2:         Temperature         1073.1 K           52         C3         C3:         Temperature         1073.1 K           53         C4         C4:         Temperature         1073.1 K           54         C5         C5:         Temperature         1073.1 K           55         C6         C6:         Temperature         1073.1 K           56         C7         C7:         Temperature         1073.1 K           56         C6         C6:         Temperature         1073.1 K           57         C8         C8:         Temperature         1073.1 K           58         C9         C9:         Temperature         1073.1 K           58         C10         C10:         Temperature         1073.1 K           59         C10         C10:         Temperature         1073.1 K           59         C10         C10:         Temperature         1073.1 K           50         C11         C11:         C11:         Temperature         1073.1 K <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	_						
50       C1       C1:       Temperature       1073.1 K         51       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         50       C10       C10:       Temperature       1073.1 K         51       C11       C11:       C11:       Temperature       1073.1 K         52       C13       C13:       C13:       Temperature       1073.1 K         52       C14       C14:       C14:       Temperature	_						
61       C2       C2:       Temperature       1073.1 K         52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       1073.1 K       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         50       C11       C11:       C11:       Temperature       1073.1 K         51       C12       C12:       C13       C13:       Temperature       1073.1 K         52       C13       C13:       C13:       Temperature       1073.1 K         52       C13       C13:       C14:       Temperature       1073.1 K         53 <td></td> <td></td> <td></td> <td></td> <td></td> <td>Temperature</td> <td></td>						Temperature	
52       C3       C3:       Temperature       1073.1 K         53       C4       C4:       Temperature       1073.1 K         54       C5       C5:       Temperature       1073.1 K         56       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       1073.1 K       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         59       C11       C11:       C11:       Temperature       1073.1 K         60       C11       C11:       C12:       Temperature       1073.1 K         61       C12       C12:       C13:       C13:       C13:       C13:       C13:       C14:       1073.1 K         63       C14       C14:       C14:       Temperature       1073.1 K         64       C15       C15:       C16:       T	51	C2	C2:				1073.1 K
54         C5         C5:         Temperature         1073.1 K           56         C6         C6:         Temperature         1073.1 K           56         C7         C7:         Temperature         1073.1 K           57         C8         C8:         Temperature         1073.1 K           57         C8         C8:         Temperature         1073.1 K           58         C9         C9:         Temperature         1073.1 K           59         C10         C10:         Temperature         1073.1 K           50         C11         C11:         Temperature         1073.1 K           51         C12         C12:         Temperature         1073.1 K           52         C13         C13:         Temperature         1073.1 K           52         C13         C13:         Temperature         1073.1 K           53         C14         C14:         Temperature         1073.1 K           54         C15         C15:         Temperature         1073.1 K           56         C16         C16:         Temperature         1073.1 K		C3				Temperature	1073.1 K
55       C6       C6:       Temperature       1073.1 K         56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         60       C11       C11:       Temperature       1073.1 K         61       C12       C12:       Temperature       1073.1 K         62       C13       C13:       Temperature       1073.1 K         63       C14       C14:       Temperature       1073.1 K         64       C15       C15:       Temperature       1073.1 K						-	
56       C7       C7:       Temperature       1073.1 K         57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         60       C11       C11:       Temperature       1073.1 K         61       C12       C12:       Temperature       1073.1 K         62       C13       C13:       Temperature       1073.1 K         63       C14       C14:       Temperature       1073.1 K         64       C15       C15:       Temperature       1073.1 K							
57       C8       C8:       Temperature       1073.1 K         58       C9       C9:       Temperature       1073.1 K         59       C10       C10:       Temperature       1073.1 K         60       C11       C11:       Temperature       1073.1 K         61       C12       C12:       Temperature       1073.1 K         62       C13:       C13:       Temperature       1073.1 K         63       C14       C14:       Temperature       1073.1 K         64       C15       C15:       Temperature       1073.1 K							
58         C9         C9:         Temperature         1073.1 K           59         C10         C10:         Temperature         1073.1 K           59         C11         C11:         Temperature         1073.1 K           60         C11         C11:         Temperature         1073.1 K           61         C12         C12:         Temperature         1073.1 K           62         C13         C13:         Temperature         1073.1 K           63         C14         C14:         Temperature         1073.1 K           64         C15         C15:         Temperature         1073.1 K           66         C16         C16:         Temperature         1073.1 K							
59       C10       C10:       Temperature       1073.1 K         60       C11       C11:       Temperature       1073.1 K         61       C12       C12:       Temperature       1073.1 K         62       C13       C13:       Temperature       1073.1 K         63       C14       C14:       Temperature       1073.1 K         64       C15       C15:       Temperature       1073.1 K         65       C16       C16:       Temperature       1073.1 K							
60         C11         C11:         Temperature         1073.1 K           61         C12         C12:         Temperature         1073.1 K           62         C13         C13:         Temperature         1073.1 K           63         C14         C14:         Temperature         1073.1 K           64         C15         C15:         Temperature         1073.1 K           65         C16         C16:         Temperature         1073.1 K	_						
61       C12       C12:       Temperature       1073.1 K         62       C13       C13:       Temperature       1073.1 K         63       C14       C14:       Temperature       1073.1 K         64       C15       C15:       Temperature       1073.1 K         65       C16       C16:       Temperature       1073.1 K	-						
62         C13         C13:         Temperature         1073.1 K           63         C14         C14:         Temperature         1073.1 K           64         C15         C15:         Temperature         1073.1 K           65         C16         C16:         Temperature         1073.1 K							
63         C14         C14:         Temperature         1073.1 K           64         C15         C15:         Temperature         1073.1 K           65         C16         C16:         Temperature         1073.1 K							
64         C15         C15:         Temperature         1073.1 K           65         C16         C16:         Temperature         1073.1 K							
66 C16 C16: Temperature 1073.1 K	-						
						-	
66 Hyprotech Ltd. HYSYS.Plant v2.2.2 (Build 3806) Page 10 of 1	_			HYSYS Plant v2.2.2 (Bi	ild 3806)	romporatoro	Page 10 of 14

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2	Sec.	INL	Case Name:	C:\Documents and	Settings\mgq\Desktop\N	GNP\FY 09 Report\600 M\
3	HY	Calgary, Alberta	Unit Set:	NGNP1		
4 5		CANADA	Date/Time:	Thu Oct 01 11:50:2	2009	
6					(	
7 8		Spreadsheet: Temp Ave	erage AS	R@IPL1	(continued	Units Set: Electrolysis
9			PARAMETER	,		
10 11						
12		Exp	oortable Varia	ables		
13	Cell	Visible Name	Variable Des	cription	Variable Type	Value
14	C17	C17:			Temperature	1073.1 K
15 16	C18 C19	C18: C19:			Temperature Temperature	1073.1 K 1073.1 K
17	D1	D1:				0.4000
18	D2	D2:				0.4000
19	D3	D3:				0.4000
20	D4	D4:				0.4000
21	D5	D5:				0.4000
22 23	D6 D7	D6:				0.4000
23 24	D7 D8	D7: D8:				0.4000
24	D9	D9:				0.4000
26	D10	D10:				0.4000
27	D11	D11:				0.4000
28	D12	D12:				0.4000
29	D13	D13:				0.4000
30	D14	D14:				0.4000
31 32	D15	D15:				0.4000
33	D16 D17	D16: D17:				0.4000
34	D18	D18:				0.4000
35	D19	D19:				0.4000
36	E1	E1:			Temperature	1073.1 K
37	E2	E2:			Temperature	1073.1 K
38	E3	E3:			Temperature	1073.1 K
39 40	E4	E4:			Temperature	1073.1 K
40	E5 E6	E5: E6:			Temperature Temperature	1073.1 K 1073.1 K
42	E7	E7:			Temperature	1073.1 K
43	E8	E8:			Temperature	1073.1 K
44	E9	E9:			Temperature	1073.1 K
45	E10	E10:			Temperature	1073.1 K
46	E11	E11:			Temperature	1073.1 K
47	E12	E12:			Temperature	1073.1 K
48 49	E13 E14	E13: E14:			Temperature Temperature	1073.1 K 1073.1 K
49 50	 F1	F1:				0.4000
51	F2	F2:				0.4000
52	F3	F3:				0.4000
53	F4	F4:				0.4000
54	F5	F5:				0.4000
55	F6	F6:				0.4000
56 57	F7 F8	F7: F8:				0.4000
57 58	F0 F9	F8.				0.4000
59	F10	F10:				0.4000
60	F11	F11:				0.4000
61	F12	F12:				0.4000
62	F13	F13:				0.4000
63	F14	F14:				0.4000
64 65	F15	F15:			 Tomporaturo	0.4000 2.7285e-014 K
00	F16 Hyprote	F16:	6.Plant v2.2.2 (Bu		Temperature	Page 11 of 14

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1 2			Case Name: C:\Documents and Settings\mgq\Desktop\NG	NP\FY 09 Report\600 M\
3	HEY	INL Calgary, Alberta	Unit Set: NGNP1	
4 5		CANADA	Date/Time: Thu Oct 01 11:50:20 2009	
6				
7 8		Spreadsheet: Temp Ave	erage ASR @TPL1 (continue، س	nits Set: Electrolysis
9 10			User Variables	
11			FORMULAS	
12 13	Cell	F	ormula	Result
14	A4	=A3+F16		1073.1 K
15	A5	=A4+F16		1073.1 K
16	A6	=A5+F16		1073.1 K
17	A7	=A6+F16		1073.1 K
18	A8	=A7+F16		1073.1 K
19	A9	=A8+F16		1073.1 K
20 21	A10 A11	=A9+F16 =A10+F16		1073.1 K 1073.1 K
21	A11 A12	=A10+F16 =A11+F16		1073.1 K 1073.1 K
22	A12 A13	=A12+F16		1073.1 K
24	A14	=A13+F16		1073.1 K
25	A15	=A14+F16		1073.1 K
26	A16	=A15+F16		1073.1 K
27	A17	=A16+F16		1073.1 K
28	A18	=A17+F16		1073.1 K
29	A19	=A18+F16		1073.1 K
30	A20		D7+D9+D11+D13+D15+D17+D19+F2+F4+F6+F8+F10+F12+F1	40.00
31	B2	@if(E15==A3,F15,(1/3*F16*(B3+A20+B20+F15))/(E15-A	(3))	0.4000
32	B3	@EXP(10300/A3)*0.00003973+(B1-0.463)		0.4000
33	B4	@EXP(10300/A4)*0.00003973+(B1-0.463)		0.4000
34 35	B5 B6	@EXP(10300/A5)*0.00003973+(B1-0.463) @EXP(10300/A6)*0.00003973+(B1-0.463)		0.4000
36	B7	@EXP(10300/A7)*0.00003973+(B1-0.463)		0.4000
37	B8	@EXP(10300/A8)*0.00003973+(B1-0.463)		0.4000
38	B9	@EXP(10300/A9)*0.00003973+(B1-0.463)		0.4000
39	B10	@EXP(10300/A10)*0.00003973+(B1-0.463)		0.4000
40	B11	@EXP(10300/A11)*0.00003973+(B1-0.463)		0.4000
41	B12	@EXP(10300/A12)*0.00003973+(B1-0.463)		0.4000
42	B13	@EXP(10300/A13)*0.00003973+(B1-0.463)		0.4000
43	B14	@EXP(10300/A14)*0.00003973+(B1-0.463)		0.4000
44	B15	@EXP(10300/A15)*0.00003973+(B1-0.463)		0.4000
45 46	B16 B17	@EXP(10300/A16)*0.00003973+(B1-0.463)		0.4000
40 47	B17 B18	@EXP(10300/A17)*0.00003973+(B1-0.463) @EXP(10300/A18)*0.00003973+(B1-0.463)		0.4000
48	B10 B19	@EXP(10300/A19)*0.00003973+(B1-0.463)		0.4000
49	B20		D8+D10+D12+D14+D16+D18+F1+F3+F5+F7+F9+F11+F13)	19.20
50	C1	=A19+F16	·····	1073.1 K
51	C2	=C1+F16		1073.1 K
52	C3	=C2+F16		1073.1 K
53	C4	=C3+F16		1073.1 K
54	C5	=C4+F16		1073.1 K
55	C6	=C5+F16		1073.1 K
56 57	C7 C8	=C6+F16 =C7+F16		1073.1 K 1073.1 K
58	C9	=C8+F16		1073.1 K
59	C10	=C9+F16		1073.1 K
60	C11	=C10+F16		1073.1 K
61	C12	=C11+F16		1073.1 K
62	C13	=C12+F16		1073.1 K
63	C14	=C13+F16		1073.1 K
64	C15	=C14+F16		1073.1 K
65	C16	=C15+F16		1073.1 K
66	Hyprote	ch Ltd. HYSYS	S.Plant v2.2.2 (Build 3806)	Page 12 of 14

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Difference         Casery, Alteria (ANDA)         Duri Set:         NOMP1           Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         The Cabery Alteria (Control of the Cabery Alteria)         Def Time         Def	1			Case Name: C:\Documents and Settings\mgq\Desktop\NG	NP\FY 09 Report\600 MV	
Date Time         Thu Oct D1 11 50 20 2009           Spreadsheet:         Temp Average ASR @TPL1 (continuer units set         Destroyens           Colin         Continuer         Units Set         Destroyens           Colin         Colin         Tormain         Termain         Termain           Colin         Colin         Tormain         Termain         Termain           Colin         Colin Co	3		INL Calgary, Alberta	Unit Set: NGNP1		
Spreadsheet: Temp Average ASR @TPL1 (continue: Units Set: Electroyeis           Cell         Formula         Result           Colspan="2">Colspan="2">Result           Colspan="2">Colspan="2"           Colspan="2"          Colspan="2"	4		CANADA	Date/Time: Thu Oct 01 11:50:20 2009		
Spreadsheet: Temp Average ASR @TPL1 (continue: Units Set: Detertoyeas           FORMULAS           Cell         Result           Colspan="2">Colspan="2">Result           Cell         Result           Cell         Result           Cell         Result           Cell         Result           Cell         Result         Tormal         Result           Cell         Cell <th colspan<="" th=""><th>5 6</th><th></th><th></th><th></th><th></th></th>	<th>5 6</th> <th></th> <th></th> <th></th> <th></th>	5 6				
FORMULAS           Cell         Formula         Result           C17         =C16+F16         1073 1 K           C18         =C17+F16         1073 1 K           C19         =C16+F16         0.4000           C2         @EXP(10300LC)*C0000373+(B1-0.463)         0.4000           C3         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           C6         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           C6         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           C7         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D11         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D12         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D13         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D14         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D15         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D16         @EXP(10300LC)*C000373+(B1-0.463)         0.4000           D16         @EXP(10300LC)*C000373+(B1-0.463)         0.400	7		Spreadsheet: Temp Ave	erage ASR @TPL1 (continuec	Jnits Set: Electrolysis	
Description         FORMULAS           Cell         Formals         Result           C18         -C17+F16         1073.1 K           C18         -C17+F16         1073.1 K           C19         -C16+F16         1073.1 K           C10         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D1         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D5         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D6         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D7         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D8         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D11         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D11         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D11         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D11         @EXP(1300C)*0.00003973+(61-0.463)         0.4000           D14         @EXP(1300C)*10.00003973+(61-0.463)         0.4000           D14         @EXP(1300C)*10.00003973+(61-0.463)         0.4000           D14         @EXP(1300C)*10.00003973+(61-0.463)         0.4000           D14         @EXP(1300C)*10.00003973+(61-0.463)         0.4000     <	8 9		· · ·	<u> </u>		
2         C17         =C16+F16         1073.1 K           2         C18         =C17+F16         1073.1 K           0         C18         =C17+F16         1073.1 K           0.1         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.3         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.5         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.6         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.6         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.7         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.9         @EXP(10300C2170.0000373+(B1-0.453)         0.4000           0.10         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.11         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.13         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.14         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.15         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.16         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.16         @EXP(10300C1370.0000373+(B1-0.453)         0.4000           0.16         @EXP(10300C1370.0000373+(B1-0.453) <th>10</th> <th></th> <th></th> <th></th> <th></th>	10					
C18         c17+F19         1073.1 K           C19         c124F16         1073.1 K           C11         QEEXP(1300027) 0000373/H51-0.463)         0.4000           C2         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D3         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D5         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D7         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D7         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D7         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D11         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D11         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D11         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D11         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D14         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D14         QEEXP(1300027) 0000373/H51-0.463)         0.4000           D14         QEEXP(1300027) 10000373/H51-0.463)         0.4000           D16         QEEXP(1300021) 10000373/H51-0.463)         0.4000           D16         QEEXP(1300021) 10000373/H51-0.463)         0.4000           D17<	11			Formula		
C (1)         +C18+F18         1073.1 K           D1         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D2         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D3         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D4         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D5         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D7         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D9         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D11         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D12         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D13         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D14         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D15         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D16         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D16         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D16         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D17         @EXP(10300C17)*0.0003973+(B1-0.483)         0.4000           D18         @EXP(10300C17)*0.0003973+(B1-0.483)						
D1         gEXR(10300C170.0003373(E1-0.463)         0.4000           D2         gEXR(10300C170.0003373(E1-0.463)         0.4000           D3         gEXR(10300C170.0003373(E1-0.463)         0.4000           D5         gEXR(10300C170.0003373(E1-0.463)         0.4000           D6         gEXR(10300C170.0003373(E1-0.463)         0.4000           D7         gEXR(10300C170.0003373(E1-0.463)         0.4000           D7         gEXR(10300C170.0003373(E1-0.463)         0.4000           D7         gEXR(10300C170.0003373(E1-0.463)         0.4000           D10         gEXR(10300C170.0003373(E1-0.463)         0.4000           D11         gEXR(10300C170.0003373(E1-0.463)         0.4000           D11         gEXR(10300C170.0003373(E1-0.463)         0.4000           D11         gEXR(10300C170.0003373(E1-0.463)         0.4000           D11         gEXR(10300C170.0003373(E1-0.463)         0.4000           D13         gEXR(10300C170.0003373(E1-0.463)         0.4000           D14         gEXR(10300C170.0003373(E1-0.463)         0.4000           D16         gEXR(10300C170.0003373(E1-0.463)         0.4000           D16         gEXR(10300C170.0003373(E1-0.463)         0.4000           D17         gEXR(10300C170.0000373(E1-0.463)         0.4000	14					
D2         @EXP(10300C370.00003973(E10.465)         0.4000           D4         @EXP(10300C370.00003973(E10.465)         0.4000           D5         @EXP(10300C370.00003973(E10.465)         0.4000           D6         @EXP(10300C370.00003973(E10.465)         0.4000           D7         @EXP(10300C370.00003973(E10.465)         0.4000           D7         @EXP(10300C370.00003973(E10.463)         0.4000           D10         @EXP(10300C370.00003973(E10.463)         0.4000           D11         @EXP(10300C370.00003973(E10.463)         0.4000           D11         @EXP(10300C370.00003973(E10.463)         0.4000           D12         @EXP(10300C370.00003973(E10.463)         0.4000           D13         @EXP(10300C170.00003973(E10.463)         0.4000           D14         @EXP(10300C170.00003973(E10.463)         0.4000           D15         @EXP(10300C170.00003973(E10.463)         0.4000           D16         @EXP(10300C170.00003973(E10.463)         0.4000           D16         @EXP(10300C170.00003973(E10.463)         0.4000           D16         @EXP(10300C170.00003973(E10.463)         0.4000           D17         @EXP(10300C170.00003973(E10.463)         0.4000           D18         @EXP(10300C170.00003973(E10.463)         0.4000 <td>15</td> <td></td> <td></td> <td></td> <td></td>	15					
2         02         05         04         05×110300C470 00003973+(81-0.463)         0.4000           D5         05×110300C470 00003973+(81-0.463)         0.4000           D6         05×110300C470 00003973+(81-0.463)         0.4000           D7         05×110300C470 00003973+(81-0.463)         0.4000           D8         05×110300C470 00003973+(81-0.463)         0.4000           D9         05×110300C470 00003973+(81-0.463)         0.4000           D10         05×110300C470 00003973+(81-0.463)         0.4000           D11         05×110300C470 00003973+(81-0.463)         0.4000           D12         05×110300C470 00003973+(81-0.463)         0.4000           D13         05×110300C470 00003973+(81-0.463)         0.4000           D14         05×110300C470 00003973+(81-0.463)         0.4000           D15         05×110300C470 00003973+(81-0.463)         0.4000           D16         05×110300C470 00003973+(81-0.463)         0.4000           D17         05×110300C470 00003973+(81-0.463)         0.4000           D18         05×110300C470 00003973+(81-0.463)         0.4000           D19         05×110300C170 00003973+(81-0.463)         0.4000           E11         0173 1 K         05×11           E2         =5×116	16					
D         gb:RX(10300C3)*0:0003373:41:0.463)         0.4000           D         gb:RX(10300C13)*0:0003373:41:0.463)         0.4000           E         sb:R1:130:13:13:13:13:13:13:13:13:13:13:13:13:13:	17					
DB         © EXP(13000CF)*00003973*(B1-0.463)         0.4000           D1         © EXP(10300CF)*00003973*(B1-0.463)         0.4000           D10         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D11         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D11         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D11         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D12         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D13         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D16         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D17         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D18         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D19         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D18         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D18         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           D18         © EXP(10300CF)*0.00003973*(B1-0.463)         0.4000           E 24         =E14*F16         1073.1 K           E 54         =E2*F16         1073.1 K           E 54         =E2*F16         1073.1 K	18	D4				
D7         ©EXP(13300CF)*0.0003973*(81-0.463)         0.4000           D8         @EXP(10300C3)*0.00003973*(81-0.463)         0.4000           D10         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D11         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D12         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D13         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D14         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D15         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D16         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D17         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D18         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D19         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D11         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D18         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           D18         @EXP(10300C1)*0.0003973*(81-0.463)         0.4000           E1         ===1+F16         1073.1 K           E2         ==E1+F16         1073.1 K           E3         ===2+F16         1073.1 K           E4	19	D5	@EXP(10300/C5)*0.00003973+(B1-0.463)		0.4000	
D8         ©EXP(13000CF)*0.0003973+(B1-0.463)         0.4000           D10         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D11         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D12         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D13         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D14         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D15         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D16         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D17         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D18         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D19         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           D19         @EXP(10300CF)*0.0003973+(B1-0.463)         0.4000           E 21         ===1+16         1073.1 K           E 22         ==E1+16         1073.1 K           E 23         ==E1+16         1073.1 K           E 24         ==E1+16         1073.1 K           E 15         ==E4+16         1073.1 K           E 16         ==E3+16         1073.1 K           E 17         ==E3+16         1073.1 K	20	D6	@EXP(10300/C6)*0.00003973+(B1-0.463)		0.4000	
DB         @EXP(10300C9)*0.0003373+(B1-0.483)         0.4000           D101         @EXP(10300C11)*0.0000373+(B1-0.483)         0.4000           D113         @EXP(10300C12)*0.0000373+(B1-0.483)         0.4000           D114         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D114         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D116         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D116         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D117         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D118         @EXP(10300C14)*0.0000373+(B1-0.483)         0.4000           D119         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           D119         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           D116         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           D118         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           D119         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           D119         @EXP(10300C14)*0.00003973+(B1-0.483)         0.4000           E11         =E14+F16         1073.1 K           D119         @EXP(10300C14)*0.0003973+(B1-0.483)         0.4000           E110         =E12+F16	21	D7	@EXP(10300/C7)*0.00003973+(B1-0.463)		0.4000	
D10         @EXP(10300C11P0.00003973+(B1-0.463)         0.4000           D11         @EXP(10300C12P0.00003973+(B1-0.463)         0.4000           D13         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D14         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D15         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D16         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D17         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D18         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300C13P0.00003973+(B1-0.463)         0.4000           E12         =E14F16         1073.1 K           E2         =E14F16         1073.1 K           E3         =E24F16         1073.1 K           E4         =E34F16         1073.1 K           E5         =E4+F16         1073.1 K           E6         =E34F16         1073.1 K           E12         =E14F16         1073.1 K           E14         =E14F16         1073.1 K           E15         =E4+F16         1073.1 K           E16         =E34F16	22	D8	@EXP(10300/C8)*0.00003973+(B1-0.463)		0.4000	
D11         @EXP(10300C11)*0.00003973+(81-0.43)         0.4000           D13         @EXP(10300C13)*0.00003973+(81-0.43)         0.4000           D14         @EXP(10300C13)*0.00003973+(81-0.43)         0.4000           D16         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           D17         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           D17         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           D18         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           D19         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           D19         @EXP(10300C16)*0.00003973+(81-0.43)         0.4000           E1         =C19+F18         1073.1 K           E2         =E1+F16         1073.1 K           E3         =E2+F16         1073.1 K           E4         =E3+F16         1073.1 K           E5         =E4+F16         1073.1 K           E6         =E6+F16         1073.1 K           E1         =E19+F16         1073.1 K           E1         =E10+F16         1073.1 K           E1         =E10+F16         1073.1 K           E1         =E10+F16         1073.1 K           E1         =E10+F16         1073.1 K     <	23					
D12         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D13         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D15         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D16         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D17         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D18         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D11         EE         =E2+F16         1073.1 K           D11         EE         =E2+F16         1073.1 K           D11         EE         =E4+F16         1073.1 K           D11         EE         =E7+F16         1073.1 K           D11         EE         =E7+F16         1073.1 K           D11         EE         =E7+F16         1073.1 K           D11         =E1+F16         1073.1	24					
D13         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D14         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D16         @EXP(10300/C13/*0.0003973+(B1-0.463)         0.4000           D17         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D18         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300/C13/*0.00003973+(B1-0.463)         0.4000           E1         -C18+716         1073.1 K           E2         =E1+F16         1073.1 K           E3         =E2+F16         1073.1 K           E4         =E3+F16         1073.1 K           E5         =E6+F16         1073.1 K           E6         =E5+F16         1073.1 K           E1         =E1+F16         1073.1 K	25					
D14         @EXP(10300/C14 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           D15         @EXP(10300/C15 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           D17         @EXP(10300/C15 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           D18         @EXP(10300/C15 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           D19         @EXP(10300/C15 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           D19         @EXP(10300/C15 <sup>10</sup> 0.0003973+(B1-0.463)         0.4000           E1         -C18+F16         1073 1 K           E2         =E1+F16         1073 1 K           E3         =E2+F16         1073 1 K           E4         =E3+F16         1073 1 K           E5         =E4+F16         1073 1 K           E6         =E5+F16         1073 1 K           E7         =E6+F16         1073 1 K           E16         =E7+F16         1073 1 K           E17         =E16         1073 1 K           E18         =E7+F16         1073 1 K           E19         =E9+F16         1073 1 K           E11         =E10+F16         1073 1 K           E12         =E14+F16         1073 1 K           E13         =E12+F16         1073 1 K           E14         =E13+F16	26					
D15         @EXP(10300/C15)*0.00003973+(B1-0.463)         0.4000           D16         @EXP(10300/C15)*0.00003973+(B1-0.463)         0.4000           D17         @EXP(10300/C15)*0.00003973+(B1-0.463)         0.4000           D18         @EXP(10300/C15)*0.00003973+(B1-0.463)         0.4000           D19         @EXP(10300/C15)*0.00003973+(B1-0.463)         0.4000           E1         =C19+F16         1073.1 K           E2         =E1+F16         1073.1 K           E3         =E2+F16         1073.1 K           E4         =E3+F16         1073.1 K           E6         =E5+F16         1073.1 K           E7         =E6+F16         1073.1 K           E1         E1         =E1+F16         1073.1 K           E1         E5         =E4+F16         1073.1 K           E1         E6         =E5+F16         1073.1 K           E1         E1         =E1+F16         1073.1 K           E1         =E1+F16         1073.1 K         1073.1 K	27					
D16         @EXP(10300/C10)*0.00003973+(B1-0.463)         0.4000           D17         @EXP(10300/C10)*0.00003973+(B1-0.463)         0.4000           S118         @EXP(10300/C10)*0.00003973+(B1-0.463)         0.4000           S119         @EXP(10300/C10)*0.00003973+(B1-0.463)         0.4000           S119         @EXP(10300/C10)*0.00003973+(B1-0.463)         0.4000           S119         @EXP(10300/C10)*0.00003973+(B1-0.463)         1073.1 K           S12         =E2+F16         1073.1 K           S12         =E2+F16         1073.1 K           S12         E4         =E3+F16         1073.1 K           S12         E5         =E4+F16         1073.1 K           S13         =E12+F16         1073.1 K         1073.1 K           S14         =E13+F16         1073.1 K         1073.1 K           <	28					
D17         @EXP(10300/C17)*0.00003973+(B1-0.463)         0.4000           2 D18         @EXP(10300/C18)*0.00003973+(B1-0.463)         0.4000           4 E1         =C19+F16         1073.1 K           5 E2         =E1+F16         1073.1 K           6 E3         =E2+F16         1073.1 K           7 E4         =E3+F16         1073.1 K           8 E5         =E4+F16         1073.1 K           9 E5         =E4+F16         1073.1 K           10 E5         =E4+F16         1073.1 K           10 E6         =E5+F16         1073.1 K           10 E7         =E6+F16         1073.1 K           10 E1         E8         =E7+F16         1073.1 K           10 E1         E1         =E10+F16         1073.1 K           11 E8         =E7+F16         1073.1 K         1073.1 K           12 E1         =E11+F16         1073.1 K         1073.1 K           13 E12         =E12+F16         1073.1 K         1073.1 K           14 E11         =E13+F16         1073.1 K         1073.1 K           15 E14         =E13+F16         1073.1 K         1073.1 K           16 E14         =E13+F16         1073.1 K         1073.1 K           1	29		• • • • • •			
D18         @EXP(10300/C18)*0.0003973+(B1-0.463)         0.4000           2 D19         @EXP(10300/C19)*0.0003973+(B1-0.463)         0.4000           2 E1         =C19+F18         1073.1 K           5         E2         =E1+F16         1073.1 K           6         E3         =E2+F16         1073.1 K           7         E4         =E3+F16         1073.1 K           8         E5         =E4+F16         1073.1 K           9         E6         =E5+F16         1073.1 K           10         E6         =E5+F16         1073.1 K           10         E8         =E7+F16         1073.1 K           10         E8         =E7+F16         1073.1 K           11         E8         =E7+F16         1073.1 K           11         E10+F16         1073.1 K         1073.1 K           11         E11         =E10+F16         1073.1 K         1073.1 K           12         E11+F16         1073.1 K         1073.1 K         1073.1 K           12         E14         =E13+F16         1073.1 K         1073.1 K           14         =E13+F16         1073.1 K         1073.1 K         1073.1 K           15         F1	30 31					
D19         @EXP(10300/C19)*0.0003973+(81-0.463)         0.4000           I         = C19+F16         1073.1 K           I         E2         = E1+F16         1073.1 K           I         E3         =E2+F16         1073.1 K           I         E4         =E3+F16         1073.1 K           I         E4         =E3+F16         1073.1 K           I         E5         =E4+F16         1073.1 K           I         E6         =E5+F16         1073.1 K           I         E8         =E7+F16         1073.1 K           I         E11         =E10+F16         1073.1 K           I         E12         =E11+F16         1073.1 K           I         E13         =E12+F16         1073.1 K           I         E14         =E13+F16         1073.1 K           I         E14         =E14-F16         1073.1 K           I         E14         =E12+F16         1073.1 K           I         E14         =E12+F16	32					
E1       = C19+F16       1073.1 K         E2       =E1+F16       1073.1 K         E3       =E2+F16       1073.1 K         E4       =E3+F16       1073.1 K         E5       =E4+F16       1073.1 K         E6       =E5+F16       1073.1 K         E6       =E5+F16       1073.1 K         E7       =E6+F16       1073.1 K         E9       =E3+F16       1073.1 K         E10       =E9+F16       1073.1 K         E11       =E10+F16       1073.1 K         E12       =E9       =E3+F16       1073.1 K         E13       =E12+F16       1073.1 K       1073.1 K         E14       =E10+F16       1073.1 K       1073.1 K         E13       =E12+F16       1073.1 K       1073.1 K         E14       =E13+F16       1073.1 K       1073.1 K         E14       =E13+F16       1073.1 K       0.4000         F1       @EXP(10300/E2)*0.0003973+(B1-0.463)       0.4000         F2       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         F5       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         F6       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000	33					
E         E2         =E1+F16         1073.1 K           8         E3         =E2+F16         1073.1 K           9         E4         =E3+F16         1073.1 K           10         E5         =E4+F16         1073.1 K           10         E5         =E4+F16         1073.1 K           10         E7         =E6+F16         1073.1 K           10         E7         =E6+F16         1073.1 K           10         E8         =E7F+16         1073.1 K           11         E8         =E7F+16         1073.1 K           12         E9         =E8+F16         1073.1 K           15         E12         =E11+F16         1073.1 K           15         E12         =E11+F16         1073.1 K           16         E13         =E12+F16         1073.1 K           16         F11         @EXP(10300/E1/10.0003873+(B1-0.463)         0.4000           17         Z+14         =E13+F16         0.4000           17         GEXP(10300/E3/10.0003873+(B1-0.463)         0.4000           17         @EXP(10300/E1/10.0003873+(B1-0.463)         0.4000           18         F4         @EXP(10300/E1/10.00003873+(B1-0.463)         0.4000	34					
E3         =E2+F16         1073.1 K           7         E4         =E3+F16         1073.1 K           10         E5         =E4+F16         1073.1 K           10         E6         =E5+F16         1073.1 K           10         E6         =E5+F16         1073.1 K           10         E7         =E6+F16         1073.1 K           10         E8         =E7+F16         1073.1 K           10         E9         =E8+F16         1073.1 K           10         E10         =E9+F16         1073.1 K           10         E11         =E10+F16         1073.1 K           10         E11         =E10+F16         1073.1 K           10         E11         =E13+F16         1073.1 K           10         E14         =E13+F16         1073.1 K           10         @EXP(10300/E1)*0.0003973+(B1-0.463)         0.4000           10         F1         @EXP(10300/E2)*0.00003973+(B1-0.463)         0.4000           11         F4         #E13+F16         0.4000           12         F5         @EXP(10300/E3)*0.00003973+(B1-0.463)         0.4000           13         F6         @EXP(10300/E3)*0.00003973+(B1-0.463)         0.4000	35					
E4       =E3+F16       1073.1 K         B       E5       =E4+F16       1073.1 K         B       E6       =E5+F16       1073.1 K         C       E7       =E6+F16       1073.1 K         C       E7       =E6+F16       1073.1 K         C       E9       =E8+F16       1073.1 K         C       E9       =E8+F16       1073.1 K         C       E9       =E8+F16       1073.1 K         C       E10       =E10+F16       1073.1 K         C       E11       =E12+F16       1073.1 K         C       E12       =E11+F16       1073.1 K         C       E13       =E12+F16       1073.1 K         C       E14       =E13+F16       1073.1 K         C       E14       =E12+F16       1073.1 K         C       E12       =E11+F16       1073.1 K         C       E14       =E13+F16       1073.1 K         C       E14       =E12+F16       0.4000         F1       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         F3       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         C       F5       @EXP(10300/E3)*0.00003973+(B1-0.463)	36					
B         E5         =E4+F16         1073.1 K           0         E6         =E5+F16         1073.1 K           0         E7         =E6+F16         1073.1 K           10         E7         =E6+F16         1073.1 K           11         E8         =E7+F16         1073.1 K           12         E9         =E3+F16         1073.1 K           14         E11         =E10+F16         1073.1 K           15         E12         =E11+F16         1073.1 K           16         E13         =E12+F16         1073.1 K           16         E14         =E13+F16         1073.1 K           17         E14         =E13+F16         1073.1 K           18         F1         @EXP(10300/E1)*0.0003973+(B1-0.463)         0.4000           19         F2         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F3         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F5         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F7         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F7         @EXP(10300/E3)*0.00003973+(B1-0.463)         0.4000	37					
0     E7     =E6+F16     1073.1 K       11     E8     =E7+F16     1073.1 K       12     E9     =E8+F16     1073.1 K       13     E10     E59+F16     1073.1 K       14     E11     =E10+F16     1073.1 K       15     E12     =E11+F16     1073.1 K       16     E13     =E12+F16     1073.1 K       16     E13     =E12+F16     1073.1 K       17     E14     =E13+F16     1073.1 K       18     F1     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       19     F2     @EXP(10300/E2)*0.0003973*(B1-0.463)     0.4000       10     F3     @EXP(10300/E2)*0.0003973*(B1-0.463)     0.4000       10     F4     @EXP(10300/E3)*0.0003973*(B1-0.463)     0.4000       10     F5     @EXP(10300/E5)*0.0003973*(B1-0.463)     0.4000       10     F6     @EXP(10300/E5)*0.0003973*(B1-0.463)     0.4000       10     F7     @EXP(10300/E3)*0.0003973*(B1-0.463)     0.4000       10     F7     @EXP(10300/E3)*0.0003973*(B1-0.463)     0.4000       10     F10     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       10     F11     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       17     F10     @EXP(10300/E1)	38					
E8         =E7+F16         1073.1 K           2         E9         =E8+F16         1073.1 K           3         E10         =E9+F16         1073.1 K           4         E11         =E10+F16         1073.1 K           5         E12         =E11+F16         1073.1 K           6         E13         =E12+F16         1073.1 K           7         E14         =E13+F16         1073.1 K           8         F1         @EXP(1030/E1)*0.0003973*(B1-0.463)         0.4000           9         F2         @EXP(1030/E3)*0.0003973*(B1-0.463)         0.4000           16         F4         @EXP(1030/E3)*0.0003973*(B1-0.463)         0.4000           17         F4         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           16         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           17         F6         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           16         F7         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           17         F10         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           16         F7         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           17         F10         @EXP(10300/E10)*0.0003973*(B1	39	E6	=E5+F16		1073.1 K	
2         E9         =E8+F16         1073.1 K           3         E10         =E9+F16         1073.1 K           4         E11         =E10+F16         1073.1 K           5         E12         =E11+F16         1073.1 K           6         E13         =E12+F16         1073.1 K           7         E14         =E13+F16         1073.1 K           8         F1         @EXP(10300/E1)*0.0003973+(B1-0.463)         0.4000           9         F2         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           9         F2         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F4         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F4         @EXP(10300/E3)*0.0003973+(B1-0.463)         0.4000           10         F4         @EXP(10300/E5)*0.0003973+(B1-0.463)         0.4000           10         F5         @EXP(10300/E5)*0.0003973+(B1-0.463)         0.4000           10         F7         @EXP(10300/E5)*0.0003973+(B1-0.463)         0.4000           10         F7         @EXP(10300/E5)*0.0003973+(B1-0.463)         0.4000           10         F11         @EXP(10300/E10)*0.0003973+(B1-0.463)         0.4000           1	40	E7	=E6+F16		1073.1 K	
8       E10       =E9+F16       1073.1 K         44       E11       =E10+F16       1073.1 K         5       E12       =E11+F16       1073.1 K         6       E13       =E12+F16       1073.1 K         7       E14       =E13+F16       1073.1 K         9       F1       @EXP(10300/E1)*0.0003973+(B1-0.463)       0.4000         9       F2       @EXP(10300/E2)*0.0003973+(B1-0.463)       0.4000         9       F3       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         10       F4       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         10       F4       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000         10       F7       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         10       F7       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         10       F7       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         10       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         10       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         10       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         11       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         12       @EXP(10300/E10)	41	E8	=E7+F16		1073.1 K	
44       E11       =E10+F16       1073.1 K         45       E12       =E11+F16       1073.1 K         46       E13       =E12+F16       1073.1 K         47       E14       =E13+F16       1073.1 K         48       F1       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         49       F2       @EXP(10300/E2)*0.0003973*(B1-0.463)       0.4000         40       F3       @EXP(10300/E3)*0.0003973*(B1-0.463)       0.4000         41       F4       @EXP(10300/E3)*0.0003973*(B1-0.463)       0.4000         42       F5       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         44       F7       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         45       F8       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         46       F7       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         47       F10       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         48       F11       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         49       F11       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         49       F11       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         40       F11       @EXP(10300/E1)*0.00039	42	E9	=E8+F16		1073.1 K	
5       E12       =E11+F16       1073.1 K         66       E13       =E12+F16       1073.1 K         77       E14       =E13+F16       1073.1 K         87       F1       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         98       F2       @EXP(10300/E2)*0.00003973+(B1-0.463)       0.4000         91       F2       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         91       F4       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         91       F4       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         92       F6       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         93       F6       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         94       F7       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         95       F8       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         96       F9       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         97       F10       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         96       F11       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         97       F10       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         96       F11 <td>43</td> <td>E10</td> <td>=E9+F16</td> <td></td> <td>1073.1 K</td>	43	E10	=E9+F16		1073.1 K	
8       E13       =E12+F16       1073.1 K         77       E14       =E13+F16       1073.1 K         8       F1       @EXP(10300/E1)*0.0003973+(B1-0.463)       0.4000         9       F2       @EXP(10300/E2)*0.0003973+(B1-0.463)       0.4000         9       F3       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         10       F4       @EXP(10300/E3)*0.0003973+(B1-0.463)       0.4000         11       F4       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         12       F5       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         13       F6       @EXP(10300/E5)*0.0003973+(B1-0.463)       0.4000         14       F7       @EXP(10300/E1)*0.0003973+(B1-0.463)       0.4000         15       F8       @EXP(10300/E1)*0.0003973+(B1-0.463)       0.4000         16       F9       @EXP(10300/E1)*0.0003973+(B1-0.463)       0.4000         17       F10       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         16       F11       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         17       F10       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         16       F11       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         17	44					
17       E14       =E13+F16       1073.1 K         18       F1       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         19       F2       @EXP(10300/E2)*0.00003973+(B1-0.463)       0.4000         10       F3       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         11       F4       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         12       F5       @EXP(10300/E3)*0.00003973+(B1-0.463)       0.4000         12       F5       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000         13       F6       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000         14       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000         15       F8       @EXP(10300/E5)*0.00003973+(B1-0.463)       0.4000         16       F9       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         17       F10       @EXP(10300/E1)*0.00003973+(B1-0.463)       0.4000         18       F11       @EXP(10300/E12)*0.00003973+(B1-0.463)       0.4000         19       F12       @EXP(10300/E13)*0.00003973+(B1-0.463)       0.4000         10       F13       @EXP(10300/E13)*0.0003973+(B1-0.463)       0.4000         11       @EXP(10300/E13)*0.0003973+(B1-0.463)       0.4000         12 <td>45</td> <td></td> <td></td> <td></td> <td></td>	45					
18       F1       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         19       F2       @EXP(10300/E2)*0.0003973*(B1-0.463)       0.4000         10       F3       @EXP(10300/E3)*0.0003973*(B1-0.463)       0.4000         11       F4       @EXP(10300/E4)*0.0003973*(B1-0.463)       0.4000         12       F5       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         13       F6       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         14       F7       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         15       F8       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         16       F7       @EXP(10300/E5)*0.00003973*(B1-0.463)       0.4000         16       F7       @EXP(10300/E1)*0.00003973*(B1-0.463)       0.4000         16       F8       @EXP(10300/E1)*0.00003973*(B1-0.463)       0.4000         17       F10       @EXP(10300/E10)*0.00003973*(B1-0.463)       0.4000         17       F10       @EXP(10300/E10)*0.00003973*(B1-0.463)       0.4000         18       F11       @EXP(10300/E11)*0.00003973*(B1-0.463)       0.4000         19       F12       @EXP(10300/E12)*0.00003973*(B1-0.463)       0.4000         19       F13       @EXP(10300/E13)*0.00003973*(B1-0.463)	46					
19     F2     @EXP(10300/E2)*0.0003973*(B1-0.463)     0.4000       10     F3     @EXP(10300/E3)*0.0003973*(B1-0.463)     0.4000       11     F4     @EXP(10300/E5)*0.0003973*(B1-0.463)     0.4000       12     F5     @EXP(10300/E5)*0.0003973*(B1-0.463)     0.4000       13     F6     @EXP(10300/E5)*0.0003973*(B1-0.463)     0.4000       14     F7     @EXP(10300/E6)*0.0003973*(B1-0.463)     0.4000       15     F8     @EXP(10300/E6)*0.0003973*(B1-0.463)     0.4000       16     F7     @EXP(10300/E6)*0.0003973*(B1-0.463)     0.4000       16     F7     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       16     F8     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       17     F10     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       18     F11     @EXP(10300/E1)*0.0003973*(B1-0.463)     0.4000       19     F12     @EXP(10300/E11)*0.0003973*(B1-0.463)     0.4000       10     F11     @EXP(10300/E13)*0.0003973*(B1-0.463)     0.4000       10     F13     @EXP(10300/E13)*0.0003973*(B1-0.463)     0.4000       10     F14     @EXP(10300/E13)*0.0003973*(B1-0.463)     0.4000       14     @EXP(10300/E13)*0.0003973*(B1-0.463)     0.4000       15     @EXP(10300/E13)*0.00003973*(B1-0.463)	47					
0         F3         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           01         F4         @EXP(10300/E4)*0.0003973*(B1-0.463)         0.4000           02         F5         @EXP(10300/E5)*0.0003973*(B1-0.463)         0.4000           03         F6         @EXP(10300/E6)*0.0003973*(B1-0.463)         0.4000           04         F7         @EXP(10300/E6)*0.0003973*(B1-0.463)         0.4000           05         F8         @EXP(10300/E6)*0.0003973*(B1-0.463)         0.4000           05         F8         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           06         F9         @EXP(10300/E3)*0.0003973*(B1-0.463)         0.4000           07         F10         @EXP(10300/E1)*0.0003973*(B1-0.463)         0.4000           08         F11         @EXP(10300/E1)*0.0003973*(B1-0.463)         0.4000           09         FXP(10300/E1)*0.0003973*(B1-0.463)         0.4000         0.4000           09         F11         @EXP(10300/E13)*0.0003973*(B1-0.463)         0.4000           09         F12         @EXP(10300/E13)*0.0003973*(B1-0.463)         0.4000           01         F14         @EXP(10300/E13)*0.0003973*(B1-0.463)         0.4000           02         F13         @EXP(10300/E13)*0.0003973*(B1-0.463)         0.4000	48					
1     F4     @EXP(10300/E4)*0.0003973+(B1-0.463)     0.4000       22     F5     @EXP(10300/E5)*0.0003973+(B1-0.463)     0.4000       33     F6     @EXP(10300/E6)*0.0003973+(B1-0.463)     0.4000       44     F7     @EXP(10300/E6)*0.0003973+(B1-0.463)     0.4000       55     @EXP(10300/E8)*0.0003973+(B1-0.463)     0.4000       56     @EXP(10300/E8)*0.0003973+(B1-0.463)     0.4000       57     @EXP(10300/E8)*0.0003973+(B1-0.463)     0.4000       56     F8     @EXP(10300/E8)*0.0003973+(B1-0.463)     0.4000       57     F10     @EXP(10300/E10)*0.0003973+(B1-0.463)     0.4000       58     F11     @EXP(10300/E11)*0.0003973+(B1-0.463)     0.4000       59     @EXP(10300/E12)*0.0003973+(B1-0.463)     0.4000       59     F12     @EXP(10300/E12)*0.0003973+(B1-0.463)     0.4000       59     F12     @EXP(10300/E13)*0.0003973+(B1-0.463)     0.4000       50     F13     @EXP(10300/E14)*0.0003973+(B1-0.463)     0.4000       50     F14     @EXP(10300/E15)*0.0003973+(B1-0.463)     0.4000       50     F15     @EXP(10300/E15)*0.0003973+(B1-0.463)     0.4000       51     @EXP(10300/E15)*0.0003973+(B1-0.463)     0.4000       51     @EXP(10300/E15)*0.0003973+(B1-0.463)     0.4000       51     @EXP(	49 50					
22       F5       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         33       F6       @EXP(10300/E5)*0.0003973*(B1-0.463)       0.4000         44       F7       @EXP(10300/E7)*0.0003973*(B1-0.463)       0.4000         55       F8       @EXP(10300/E3)*0.00003973*(B1-0.463)       0.4000         56       F9       @EXP(10300/E3)*0.00003973*(B1-0.463)       0.4000         57       F10       @EXP(10300/E10)*0.00003973*(B1-0.463)       0.4000         58       F9       @EXP(10300/E10)*0.00003973*(B1-0.463)       0.4000         59       @EXP(10300/E11)*0.00003973*(B1-0.463)       0.4000         58       F11       @EXP(10300/E12)*0.00003973*(B1-0.463)       0.4000         59       F12       @EXP(10300/E12)*0.00003973*(B1-0.463)       0.4000         50       F12       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         50       F13       @EXP(10300/E14)*0.00003973*(B1-0.463)       0.4000         51       @EXP(10300/E15)*0.00003973*(B1-0.463)       0.4000         52       F16       =(E15-A3)/50       2.7285e-014 K         4	51					
33       F6       @EXP(10300/E6)*0.0003973*(B1-0.463)       0.4000         44       F7       @EXP(10300/E3)*0.0003973*(B1-0.463)       0.4000         45       F8       @EXP(10300/E3)*0.00003973*(B1-0.463)       0.4000         46       F9       @EXP(10300/E3)*0.00003973*(B1-0.463)       0.4000         47       F10       @EXP(10300/E3)*0.00003973*(B1-0.463)       0.4000         48       F11       @EXP(10300/E11)*0.00003973*(B1-0.463)       0.4000         49       F12       @EXP(10300/E12)*0.00003973*(B1-0.463)       0.4000         49       F12       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         40       F13       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         40       F14       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         41       F14       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         42       F15       @EXP(10300/E14)*0.0003973*(B1-0.463)       0.4000         43       F16       =(E15-A3)/50       2.7285e-014 K	52					
44       F7       @EXP(10300/E7)*0.0003973*(B1-0.463)       0.4000         55       F8       @EXP(10300/E8)*0.0003973*(B1-0.463)       0.4000         56       F9       @EXP(10300/E1)*0.0003973*(B1-0.463)       0.4000         57       F10       @EXP(10300/E1)*0.00003973*(B1-0.463)       0.4000         58       F11       @EXP(10300/E1)*0.00003973*(B1-0.463)       0.4000         59       F12       @EXP(10300/E11)*0.00003973*(B1-0.463)       0.4000         59       F12       @EXP(10300/E12)*0.00003973*(B1-0.463)       0.4000         59       F12       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         59       F13       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         50       F14       @EXP(10300/E13)*0.00003973*(B1-0.463)       0.4000         51       F14       @EXP(10300/E15)*0.00003973*(B1-0.463)       0.4000         52       F15       @EXP(10300/E15)*0.00003973*(B1-0.463)       0.4000         52       F16       =(E15-A3)/50       2.7285e-014 K         54       HYSYS.Plant v2.2.2 (Build 3806)       Page 13 of 14	53					
55       F8       @EXP(10300/E8)*0.0003973+(B1-0.463)       0.4000         56       F9       @EXP(10300/E9)*0.0003973+(B1-0.463)       0.4000         57       F10       @EXP(10300/E10)*0.00003973+(B1-0.463)       0.4000         58       F11       @EXP(10300/E10)*0.00003973+(B1-0.463)       0.4000         59       F12       @EXP(10300/E11)*0.00003973+(B1-0.463)       0.4000         59       F12       @EXP(10300/E12)*0.00003973+(B1-0.463)       0.4000         50       F13       @EXP(10300/E13)*0.00003973+(B1-0.463)       0.4000         51       @EXP(10300/E13)*0.00003973+(B1-0.463)       0.4000         52       F14       @EXP(10300/E15)*0.00003973+(B1-0.463)       0.4000         52       F15       @EXP(10300/E15)*0.00003973+(B1-0.463)       0.4000         52       F16       =(E15-A3)/50       0.4000         53       F16       =(E15-A3)/50       2.7285e-014 K         54       HYSYS.Plant v2.2.2 (Build 3806)       Page 13 of 14	54					
F9         @EXP(10300/E9)*0.0003973+(B1-0.463)         0.4000           77         F10         @EXP(10300/E10)*0.00003973+(B1-0.463)         0.4000           88         F11         @EXP(10300/E10)*0.00003973+(B1-0.463)         0.4000           99         F12         @EXP(10300/E12)*0.00003973+(B1-0.463)         0.4000           90         F13         @EXP(10300/E12)*0.0003973+(B1-0.463)         0.4000           90         F14         @EXP(10300/E13)*0.00003973+(B1-0.463)         0.4000           91         F14         @EXP(10300/E13)*0.00003973+(B1-0.463)         0.4000           92         F15         @EXP(10300/E15)*0.00003973+(B1-0.463)         0.4000           93         F16         =(E15-A3)/50         0.4000           94         F16         =(E15-A3)/50         2.7285e-014 K           95         F16         F16         HYSYS.Plant v2.2.2 (Build 3806)         Page 13 of 14	55					
77       F10       @EXP(10300/E10)*0.0003973+(B1-0.463)       0.4000         88       F11       @EXP(10300/E11)*0.0003973+(B1-0.463)       0.4000         89       F12       @EXP(10300/E12)*0.0003973+(B1-0.463)       0.4000         80       F13       @EXP(10300/E13)*0.00003973+(B1-0.463)       0.4000         81       F14       @EXP(10300/E13)*0.00003973+(B1-0.463)       0.4000         82       F15       @EXP(10300/E15)*0.0003973+(B1-0.463)       0.4000         83       F16       =(E15-A3)/50       2.7285e-014 K         ***********************************	56					
99       F12       @EXP(10300/E12)*0.0003973*(B1-0.463)       0.4000         90       F13       @EXP(10300/E13)*0.0003973*(B1-0.463)       0.4000         91       F14       @EXP(10300/E14)*0.0003973*(B1-0.463)       0.4000         92       F15       @EXP(10300/E15)*0.0003973*(B1-0.463)       0.4000         93       F16       =(E15-A3)/50       2.7285e-014 K         94	57	F10	@EXP(10300/E10)*0.00003973+(B1-0.463)		0.4000	
0         F13         @EXP(10300/E13)*0.00003973+(B1-0.463)         0.4000           01         F14         @EXP(10300/E13)*0.00003973+(B1-0.463)         0.4000           02         F15         @EXP(10300/E15)*0.00003973+(B1-0.463)         0.4000           03         F16         =(E15-A3)/50         2.7285e-014 K           04         5         5         5           06         Hyprotech Ltd.         HYSYS.Plant v2.2.2 (Build 3806)         Page 13 of 14	58		@EXP(10300/E11)*0.00003973+(B1-0.463)		0.4000	
Bit         F14         @EXP(10300/E14)*0.0003973+(B1-0.463)         0.4000           22         F15         @EXP(10300/E15)*0.0003973+(B1-0.463)         0.4000           23         F16         =(E15-A3)/50         2.7285e-014 K           24	59					
22         F15         @EXP(10300/E15)*0.00003973+(B1-0.463)         0.4000           33         F16         =(E15-A3)/50         2.7285e-014 K           34	60					
33       F16       =(E15-A3)/50       2.7285e-014 K         34	61					
34     35       36     Hyprotech Ltd.       Hyprotech Ltd.     HYSYS.Plant v2.2.2 (Build 3806)	62					
Hyprotech Ltd.         HYSYS.Plant v2.2.2 (Build 3806)         Page 13 of 14	63	F16	=(E15-A3)/50		2.7285e-014 K	
Hyprotech Ltd.         HYSYS.Plant v2.2.2 (Build 3806)         Page 13 of 14	64					
	-	Llummete	ab I ta UVOVa		Degs 42 of 44	
	66			D. FIGHT V2.2.2 (DUIIU 3000)		

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2				Case Name:	C:\Documents and	Settings\mgq\Desktop\N	GNP\FY 09 Report\600 M\
	HYPROTECH	INL Calgary, Alberta		Unit Set:	NGNP1		
4 5		CANADA		Date/Time:	Thu Oct 01 11:50:2	0 2009	
6 7	Sprea	dsheet: T	Гетр	Average A	SR @TPL1	(continue	Units Set: Electrolysis
8				Spreadsh	eet		
10 11	Α	В		C	D	E	F
12 1	ASR @ 1100 K		2776 *	1073.1 K	0.4000	1073.1 K	0.4000
3 <b>2</b>	Temp Average ASR	0.4	4000	1073.1 K	0.4000	1073.1 K	0.4000
4 <b>3</b>	1073.1 K	0.4	4000	1073.1 K	0.4000	1073.1 K	0.4000
54	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
5	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
7 6	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
3 7	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
8	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
9	1073.1 K		4000	1073.1 K	0.4000	1073.1 K	0.4000
1 10			4000	1073.1 K	0.4000	1073.1 K	0.4000
2 11 3 12			4000	1073.1 K	0.4000	1073.1 K	0.4000
			4000	1073.1 K	0.4000	1073.1 K	0.4000
			4000	1073.1 K	0.4000	1073.1 K	0.4000
5 14 5 15			4000	1073.1 K	0.4000	1073.1 K	0.4000
			4000	1073.1 K	0.4000	1073.2 K delta T	
16 17			4000 4000	1073.1 K 1073.1 K	0.4000	deita i	2.7205e-014 K
17 18			4000	1073.1 K	0.4000		
19			4000	1073.1 K	0.4000		
20			9.20	1073.1 K	0.4000		
3 4 5 6 7 8 9 9 0 1 1 2 3 4 5 6 7 7 8 9 9 0 0 1 1 2 3 4 5 5 6 7 7 8 9 9 0 0 0 0 0 0 0 0 0 0 0 0 0							
7 8 8 9 1 2 2 8 8 4 4 5 5 5 8 8 9 0 1 1 2 2 8 8 8 9 0							

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# Appendix C 55%/45% Debt to Equity Results

Table C-1. HTSE connected to a 600MWt HTGR IRR results for 55%/45% debt-to-equity ratio.

	TCI -30	% HTGR	Т	CI	TCI +50	% HTGR
	IRR	\$/kg	IRR	\$/kg	IRR	\$/kg
	\$1,000,	417,985	\$1,307,	917,985	\$1,820,	417,985
	3.66	\$1.50	1.83	\$1.50	-0.20	\$1.50
HTSE	12.27	\$3.25	9.48	\$3.25	6.54	\$3.25
	18.30	\$5.00	14.69	\$5.00	10.96	\$5.00
	12.00	\$3.18	12.00	\$4.04	12.00	\$5.48

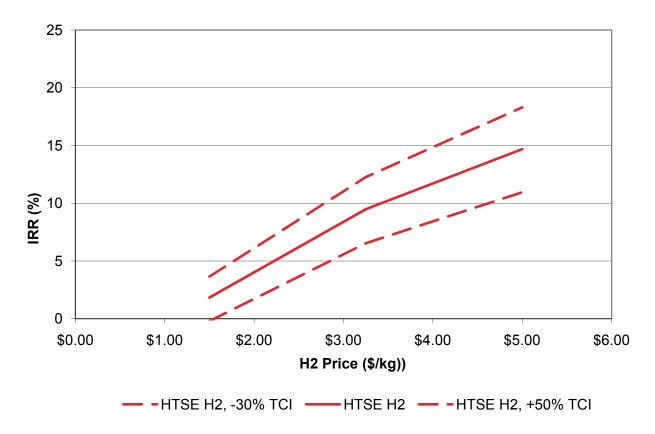


Figure C-1. HTSE connected to a 600 MWt HTGR IRR economic results for 55%/45% debt-to-equity ratio.

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# Appendix D Cost Estimate Support Data Recapitulation

Appendix D is a cost estimate of the nuclear assisted production of ammonia using high temperature steam electrolysis without an air separation unit. The cost estimate was performed by a team of cost estimators at the INL. The capital cost of hydrogen production can be found by summing the HTGR, Rankine power cycle, and HTSE costs for the production of 7.51 kg/s of hydrogen.

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Summary
ASU
ia w/c
Ammon
HTSE
NGNP

Project Name: NGNP Process Integration Process: HTSE Ammonia w/o ASU Estimate Number: MA36-O

Client: M. Patterson Prepared By: B. Wallace, R. Honsinger, J. Martin Estimate Type: Class 5

	Subtotal From Detail					
Process Component	Sheets	Engineering %	Engineering	Contingency %	Contingency	Total Cost
ligh Temperature Gas Reactor (HTGR)	S 4,201,101,415	%0	- 5	%0	\$ \$	4,201,101,415
tankine Power Cycle	S 615,345,051	10% \$	\$ 61,534,505	18% \$	\$ 121,838.320 \$	798,717,876
ligh Temperature Steam Electrolysis (HTSE)	S 363,429,475	10% \$	\$ 36,342,947	18% \$	\$ 71,959.036 \$	471,731,458
12 Generation	S 17.287.060	10% \$	\$ 1,728,706	18%	\$ 3,422,838 \$	22,438,603
CO2 Generation	S 15,022,364	10% \$	\$ 1,502,236	18%	\$ 2,974,428 \$	19,499,029
Nethanation	S 9,518,338	10% \$	\$ 951,834	18% \$	\$ 1,884,631 \$	12,354,803
mmonia Synthesis	S 297,160,814	\$ %01	\$ 29,716,081	18%	\$ 58,837,841 \$	385,714,736
Jrea Synthesis	S 288,347,019	10% \$	\$ 28,834,702	18%	\$ 57,092,710 \$	374,274,430
itric Acid Synthesis	S 272,169,749	10% \$	\$ 27,216,975	18%	\$ 53,889,610 \$	353,276,334
mmonium Nitrate Synthesis	S 173,948,476	10% \$	\$ 17,394,848	18%	S 34,441,798 \$	225,785,122
Steam Turbines	\$ 49,012,114	10% \$	\$ 4,901,211	18%	S 9,704,398 \$	63.617.723
leat Recovery Steam Generator (HRSG)	- \$	10% \$	- S	18%	s s	
Cooling Towers	\$ 5,735,762	10%	\$ 573,576	18%	\$ 1,135,681 \$	7,445,019
Tatal Cast HTCE Ammania MCH						0 001 010 10
					A	R+C'0CR'CCR'0
Total Cost Rounded to the Nearest \$10M					\$	6,940,000,000

Remarks	S
Checked By: Show	
C.17	
Approved By:	

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NUCLEAR-INTEGRATED HYDROGEN
<b>PRODUCTION ANALYSIS</b>

Rev. 03-04-10		
Battelle Energy	Alliance, LLC	
CO	ST ESTIMATE SUPPORT DATA RECAPITULAT	TION
Project Title:	NGNP Process Integration – HTSE Ammonia without ASU	
Estimator:	B. W. Wallace/CEP, R. R. Honsinger/CEP, J. B. Martin/CCT	
Date:	April 20, 2010	
Estimate Type:	Class 5	
File:	MA36-0	
Approved By:	Amta	Page 1 of 9

I. <u>**PURPOSE**</u>: Brief description of the intent of how the estimate is to be used (i.e., for engineering study, comparative analysis, request for funding, proposal, etc.).

It is expected that the capital costs identified in these estimates will be used in a model producing an economic analysis for each specific integrated application and subsequently will be considered in a related feasibility study.

- II. <u>SCOPE OF WORK</u>: Brief statement of the project's objective. Thorough overview and description of the proposed project. Identify work to be accomplished, as well as any specific work to be excluded.
  - A. Objective:

Develop Class 5 estimates as defined by the Association for Advancement of Cost Engineering (AACEi) that will identify the current capital cost associated with high-temperature gas reactors (HTGRs) integrated with a nuclear ammonia without an air separation unit process.

#### B. Included:

- The scope of work required to achieve this objective includes the following:
- 1. Engineering
- 2. The allowance provided for the HTGR represents a complete and operable system. All elements required for construction of this nuclear reactor capability, including an initial steam generator, security systems, contingency, and owner's costs are included in the turn-key allowance. Owner's costs are included only in the case of the reactor capability. It is considered that the total value represents all inside of battery limits (ISBL) elements, outside of battery limits (OSBL) elements, site development, and all ancillary control and operational functions and capabilities.
- 3. Construction of a new integrated refinery capability to produce ammonia that consists of the following:
  - a. Overnight island-type costs for HTGRs
  - b. High-temperature steam electrolysis (HTSE) hydrogen production unit
  - c. H<sub>2</sub> combustor (N<sub>2</sub> generation)
  - d. Natural gas combustor (CO<sub>2</sub> generation)
  - e. Methanation
  - f. Ammonia synthesis
  - g. Urea synthesis
  - h. Nitric acid synthesis

CO	ST ESTIMATE SUPPORT DATA RECAPITULA	ΓΙΟΝ
	– Continued –	
Project Title:	NGNP Process Integration – HTSE Ammonia without ASU	
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- i. Ammonium nitrate synthesis
- j. Steam turbines, internal to process
- k. Heat recovery steam generator, internal to process
- 1. Cooling towers, internal to process
- m. Allowances for Balance of Plant (BOP)/offsite/OSBL, including the following:
  - (1.) Site development/improvements
  - (2.) Provisions for general and administrative buildings and structures
  - (3.) Provisions for OSBL piping
  - (4.) Provisions for OSBL instrumentation and control
  - (5.) Provisions for OSBL electrical
  - (6.) Provisions for facility supply and OSBL water systems
  - (7.) Provisions for site development/improvements
  - (8.) Project/construction management.

#### C. <u>Excluded</u>:

This scope of work specifically excludes the following elements:

- 1. Licensing and permitting costs
- 2. Operational costs
- 3. Land costs
- 4. Sales taxes
- 5. Royalties
- 6. Owner's fees and owner's costs, except those included for the HTGR
- 7. The allowance provided for the HTGR capability excludes all costs associated with materials development, or costs that would not be appropriately associated with an nth of a kind (NOAK) reactor/facility.
- III. <u>ESTIMATE METHODOLOGY</u>: Overall methodology and rationale of how the estimate was developed (i.e., parametric, forced detail, bottoms up, etc.). Total dollars/hours and rough order magnitude (ROM) allocations of the methodologies used to develop the cost estimate.

Consistent with the AACEi Class 5 estimates, the level of definition and engineering development available at the time they were prepared, their intended use in a feasibility study, and the time and resources available for their completion, the costs included in this estimate have been developed using parametric evaluations. These evaluations have used publicly available and published project costs to represent similar islands utilized in this project. Analysis and selection of the published costs used have been performed by the project technical lead and Cost Estimating. Suitability for use in this effort was determined considering the correctness and completeness of the data available, the manner in which total capital costs were represented, the age of the previously performed work, and the similarity to the capacity/trains required by this project. The specific sources, selected and used in this cost estimate, are identified in the capital costs using escalation factors identified in the Chemical Engineering Price Cost Index. Scaling of the published island costs has been

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Project Title:	NGNP Process Integration – HTSE Ammonia without ASU	
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accomplished using the six-tenths capacity factoring method. Costs included for the HTGR, power cycles, and HTSE, have been identified and provided by the respective BEA subject matter experts. The total cost for each of these items has been linearly calculated from the respective base unit costs. Any normalization to provide for geographic factors was considered using geographic factors available from RS Means Construction Cost Data references. Cost-estimating relationships have been used to identify allowances to complete the costs.

It was identified to the Next Generation Nuclear Plant (NGNP) Process Integration team that the methodology employed by NGNP to develop the nuclear capability included constituents of parametric modeling, vendor quotes, actual costs, and proprietary costing databases. These preconceptual design estimates were reviewed by NGNP Project Engineering for credibility with regard to assumptions and bases of estimate and performed multiple studies to reconcile variations in the scope and assumptions within the three estimates.

BOP/OSBL costs were determined by the project team, considering data provided by Shell Gasifier IGCC Base Case report NETL 2000, *Conceptual Cost Estimating Manual* Second Edition by John S. Page, and additional adjusted sources. Because the allowances identified did not show significant variability, the allowances identified in the NETL 2000 report were chosen for this effort in order to minimize the mixing of data sources.

- IV. <u>BASIS OF THE ESTIMATE</u>: Overall explanation of sources for resource pricing and schedules.
  - A. <u>Quantification Basis</u>: The source for the measurable quantities in the estimate that can be used in support of earned value management. Source documents may include drawings, design reports, engineers' notes, and other documentation upon which the estimate is originated.

All islands and capacities have been provided to Cost Estimating by the project respective expert.

- B. <u>Planning Basis</u>: The source for the execution and strategies of the work that can be used to support the project execution plan, acquisition strategy, schedules, and market conditions and other documentation upon which the estimate is originated.
  - 1. All islands and HTGRs represent NOAK projects.
  - 2. Projects will be constructed and operated by commercial entities.
  - 3. All projects, with the exception of the Steam-Assisted Gravity Drainage Project, will be located in the U.S. Gulf Coast refinery region.
  - 4. Costs are presented as overnight costs.
  - 5. The cost estimate does not consider or address funding or labor resource restrictions. Sufficient funding and labor resources will be available in a manner that allows optimum usage of the funding and resources as estimated and scheduled.

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C.	ear inci	st Basis: The source for the costing on the estimate that can be used in support of ned value management, funding profiles, and schedule of values. Sources may lude published costing references, judgment, actual costs, preliminary quotes or er documentation upon which the estimate is originated.
	1.	All costs are represented as current value costs. Factors for forward-looking escalation and inflation factors are not included in this estimate.
	2.	Where required, published cost factors, as identified in the Chemical Engineering Plant Cost Index, will be applied to previous years' values to determine current year values.
	3.	Geographic location factors, as identified in RS Means Construction Cost Data reference manual, were considered for each source cost.
	4.	The cost provided for the HTGR reflects internal BEA cost data that was developed for the HTGR and presented to the NGNP Process Integration team by L. Demmick. Considered in the cost is a pre-conceptual cost estimate prepared by three separate contractor teams. All contractor teams proposed 4-unit NOAK plants with thermal power levels between 2,000 MW <sub>t</sub> and 2,400 MW <sub>t</sub> at a cost of roughly \$4B, including owner's cost. This equates to \$1,667 to \$2,000 per kW <sub>t</sub> . For the purposes of this report, the nominal cost of an HTGR will be set at the upper end of this range, \$2,000 per kW <sub>t</sub> . This is a complete turnkey cost and includes engineering and construction of a NOAK HTGR, the power cycle, and contingency. The total HTGR cost for each process is calculated linearly as \$1,708,333 per MWth of required capacity, excluding the cost of the power cycles.
	5.	The cost included for the power cycle was provided by the INL project team expert. The power cycle cost is based on the definition of a 240-MWe capacity and \$618,176 per MWe. The total power cycle cost for each process is calculated linearly as \$618,176 per MWe of required capacity. BOP, engineering, and contingency costs are added to the base cost.
	6.	The cost included for HTSE was provided by the INL project team expert. The total HTSE cost for each process is calculated linearly as \$36,120,156 per kg/s of required capacity. BOP, engineering, and contingency costs are added to the base cost.
	7.	Apt, Jay, et al., <i>An Engineering-Economic Analysis of Syngas Storage</i> , NETL, July 2008.
	8.	AACEi, Recommended Practices, website, visited November 16, 2009, http://www.aacei.org/technical/rp.shtml.
	9.	Brown, L. C., et al., "Alternative Flowsheets for the Sulfur-Iodine Thermochemical Hydrogen Cycle," <i>General Atomics</i> , February 2003.
		CEPCI, Chemical Engineering Magazine, "Chemical Engineering Plant Cost Index," November 2009: 64.
		Choi, 1996, Choi, Gerald N., et al, <i>Design/Economics of a Once-Through</i> <i>Natural Gas Fischer-Tropsch Plant with Power Co-Production</i> , Bechtel, 1996. Dooley, J., et al, <i>Carbon Dioxide Capture and Geologic Storage</i> , Battelle,
	12.	April 2006.

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13.	Douglas, Fred R., et al., Conduction Technical and Economic Evaluations – as Applied for the Process and Utility Industries, AACEi, April 1991.
14.	FLUOR/UOP, 2004, Mak, John Y., et al., Synthesis Gas Purification in Gasification to Ammonia/Urea Complex, FLUOR/UOP, 2004.
15.	Friedland, Robert J., et al., <i>Hydrogen Production Through Electrolysis</i> , NREL, June 2002.
16.	Gray, 2004, Gray, David, et al, Polygeneration of SNG, Hydrogen, Power, and Carbon Dioxide from Texas Lignite, MTR-04, 2004-18, NETL, December 2004
17.	Harvego, E. A., et al., Economic Analysis of a Nuclear Reactor Powered High-Temperature Electrolysis Hydrogen Production Plant, INL, August 2008.
18.	Harvego, E. A., et al., Economic Analysis of the Reference Design for a Nuclear-Driven High-Temperature-Electrolysis Hydrogen Production Plant, INL, January 2008.
19.	Ivy, Johanna, Summary of Electrolytic Hydrogen Production, NREL September 2004.
20.	Ibsen, Kelly, et al., Equipment Design and Cost Estimation for Small Modular Biomass Systems, Synthesis Gas Cleanup, and Oxygen Separation Equipment, NREL, May 2006.
21.	Klett, Michael G., et al., <i>The Cost of Mercury Removal in an IGCC Plant</i> , NETL, September 2002.
22.	Kreutz, 2008, Kreutz, Thomas G., et al, "Fischer-Tropsch Fuels from Coal and Biomass," 25 <sup>th</sup> Annual International Pittsburgh Coal Conference, Pittsburgh, Princeton University, October 2008.
23.	Loh, H. P., et al., <i>Process Equipment Cost Estimation</i> , DOE/NETL-2002/1169, NETL, 2002.
24.	NETL, 2000, Shelton, W., et al., <i>Shell Gasifier IGCC Base Cases</i> , PED-IGCC-98-002, NETL, June 2000.
25.	NETL, 2007a, Van Bibber, Lawrence, Baseline Technical and Economic
	Assessment of a Commercial Scale Fischer-Tropsch Liquids Facility,
	DOE/NETL-207/1260, NETL, April 2007.
26.	NETL, 2007b, Woods, Mark C., et al., <i>Cost and Performance Baseline for</i>
77	Fossil Energy Plants, NETL, August 2007.
27.	NREL, 2005, Saur, Genevieve, Wind-To-Hydrogen Project: Electrolyzer Capital Cost Study, NREL, December 2008.
28.	O'Brien, J. E., et al., High-Temperature Electrolysis for Large-Scale Hydrogen and Syngas Production from Nuclear Energy – System Simulation and
	Economics, INL, May 2009.
29.	O'Brien, J. E., et al., Parametric Study of Large-Scale Production of Syngas via
	High-Temperature Co-Electrolysis, INL, January 2009.
30.	Page, John S., Conceptual Cost Estimating Manual – 2 <sup>nd</sup> ed., Houston: Gulf
	Publishing Company, 1996.
31.	Pietlock, Bernard A., et al., <i>Developing Location Factors by Factoring- as Applied in Architecture, Engineering, Procurement, and Construction</i> , AACEi, October 2006.

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VI.

<u> </u>	ST ESTIMATE SUPPORT DATA RECAPITULATION
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33.	Ramsden, Todd, et al., Longer-Term (2025) Hydrogen Production from Central Grid Electrolysis, NREL, May 2008.
34.	Richardson Construction Estimating Standards, <i>Process Plant Cooling Towers</i> , Cost Data Online, September 16, 2009, website, visited December 15, 2009, http://www.costdataonline.com/.
35.	Sohal, M. S., et al., Challenges in Generating Hydrogen by High Temperature Electrolysis Using Solid Oxide Cells, INL, March 2008.
36.	Steinberg, Meyer, Conversion of Coal to Substitute Natural Gas (SNG), HCE, 2005.
37.	Udengaard, 2008, Udengaard, Niels R., et al., Convert Coal, petcoke into valuable SNG, Haldor Topsoe, April 2008.
38.	van der Ploeg, H. J., et al., <i>The Shell Coal Gasification Process for the US Industry</i> , Shell, October 2004.
39.	WorleyParsons, 2002, Rameshni, Mahin, Cost Effective Options to Expand SRU Capacity Using Oxygen, WorleyParsons, May 2002.
	<b>TE QUALITY ASSURANCE</b> : <i>A listing of all estimate reviews that have taken the actions taken from those reviews.</i>
cost estim on the per make up th	of the cost estimate was held on January 14, 2010, with the project team and the ators. This review allowed for the project team to review and comment, in detail, ceived scope, basis of estimates, assumptions, project risks, and resources that his cost estimate. Comments from this review have been incorporated into this oreflect a project team consensus of this document.
demonstra	<b>TIONS</b> : Condition statements accepted or supposed true without proof of tion; statements adding clarification to scope. An assumption has a direct total estimated cost.

General Assumptions:

- A. All costs are represented in 2009 values.
- B. Costs that were included from sources representing years prior to 2009 have been normalized to 2009 values using the Chemical Engineering Plant Cost Index. This index was selected due to its widespread recognition and acceptance and its specific orientation toward work associated with chemical and refinery plants.
- C. Capital costs are based on process islands. The majority of these islands are interchangeable, after factoring for the differing capacities, flowsheet-to-flowsheet.
- D. All chemical processing and refinery processes will be located in the U.S. Gulf Coast region.
- E. All costs considered to be BOP costs that can be specifically identified have been factored out of the reported source data and added into the estimate in a manner consistent with that identified in the NETL 2000 IGCC Base Cost report. Inclusion of the source costs in this manner normalizes all reported cost information to the bare-erected costs.

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#### HTGR:

- A. The linearly scalable cost included for an HTGR reflects an NOAK reactor with a 750°C-operating temperature.
- B. HTGR is considered to be linearly scalable, by required capacity, per the direction of the project team. This allows the process integration feasibility studies to showcase the financial analysis of the process without the added burden of integer quantity 600-MWth HTGRs.
- C. The allowance represents a turnkey condition for the reactor and its supporting infrastructure.
- D. A high-temperature, high-pressure steam generator is included in the cost represented for HTGR.
- E. A contingency allowance is included in the HTGR cost, but is not identified as a separate line item in this estimate. This allowance was identified and included by the NGNP HTGR project team.
- F. Total cost range, including contingency, for HTGR is -50%, +100%.
- G. Cost included for the power cycle reflects NOAK research and manufacturing developments to allow for assumed high pressures and temperatures.
- H. The power cycle is considered to be linearly scalable, by required capacity, per the direction of the project team. This allows the process integration feasibility studies to showcase the financial analysis of the process.
- I. The cost included for HTSE reflects NOAK research and manufacturing developments, which will increase the expected lifespan of the electrolysis cells.
- J. The HTSE is considered to be linearly scalable, by required capacity, per the direction of the project team. This allows the process integration feasibility studies to showcase the financial analysis of the process.

#### HTSE Ammonia without Air Separation Unit

Some estimated island costs are based on figures from a verbal conversation with Casale, a leading world vendor of process industry services. These costs were used in cases where other acceptable costs were not available.

#### VII. <u>CONTINGENCY GUIDELINE IMPLEMENTATION</u>:

<u>Contingency Methodologies:</u> *Explanation of methodology used in determining overall contingency. Identify any specific drivers or items of concern.* 

At a project risk review on December 9, 2009, the project team discussed risks to the project. An 18% allowance for capital construction contingency has been included at an island level based on the discussion and is included in the summary sheet. The contingency level that was included in the island cost source documents and additional threats and opportunities identified here were considered during this review. The contingency identified was considered by the project team and included in Cost and Performance Baseline for Fossil Energy Plants DOE/NETL-2007/1281 and similar reports. Typically, contingency allowance provided in these reports ranged from 15% to 20%. Since much of

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the data contained in this estimate has been derived from these reports, the project team has also chosen a level of contingency consistent with them.

While the level of contingency provided for the HTGR capability is not identified as a line item, the cost data provided to the NGNP Process Integration team was identified as including an appropriate allocation for contingency. No additional contingency has been added to this element.

- A. <u>Threats</u>: Uncertain events that are potentially negative or reduce the probability that the desired outcome will happen.
  - 1. The singularly largest threat to this estimate surrounds the lump sum cost included for the HTGR reactor(s). This is followed by the HTSE process, where applicable. While the overriding assumption is that these elements will be NOAK, currently, a complete HTGR has not been commissioned and the HTSE has been successfully developed in an integrated laboratory-scale model, but has not been completed in either pilot plant or production scales.
  - 2. The level of project definition/development that was available at the time the estimate was prepared represents a substantial risk to the project and is likely to occur. The high level at which elements were considered and included has the potential to include additional elements that are within the work scope but not sufficiently provided for or addressed at this level.
  - 3. The estimate methodology employed is one of a stochastic parametrically evaluated process. This process used publicly available published costs that were related to the process required, costs were normalized using price indices, and the cost was scaled to provide the required capacity. The cost-estimating relationships that were used represent typical costs for BOP allowances, but source cost data from which the initial island costs were derived were not completely descriptive of the elements included, not included, or simply referred to with different nomenclature or combined with other elements. While every effort has been made to correctly normalize and factor the costs for use in this effort, the risk exists that not all of these were correctly captured due to the varied information available.
  - 4. This project is heavily dependent on metals, concrete, petroleum, and petroleum products. Competition for these commodities in today's environment due to global expansion, uncertainty, and product shortages affects the basic concepts of the supply and demand theories, thus increasing costs.
  - 5. Impacts due to large quantities of materials, special alloy materials, fabrication capability, and labor availability could all represent conditions that may increase the total cost of the project.

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- B. **Opportunities**: Uncertain events that could improve the results or improve the probability that the desired outcome will happen.
  - 1. Additional research and work performed with both vendors and potential owner/operators for a specific process or refinery may identify efficiencies and production means that have not been available for use in this analysis.
  - 2. Recent historical data may identify and include technological advancements and efficiencies not included or reflected in the publicly available source data used in this effort.

Note: Contingency does not increase the overall accuracy of the estimate; it does, however, reduce the level of risk associated with the estimate. Contingency is intended to cover the inadequacies in the complete project scope definition, estimating methods, and estimating data. Contingency specifically excludes changes in project scope, unexpected work stoppages (e.g., strikes, disasters, and earthquakes) and excessive or unexpected inflation or currency fluctuations.

#### VIII. OTHER COMMENTS/CONCERNS SPECIFIC TO THE ESTIMATE:

None.

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					Detail Item Repol	rt - High Temperat	Detail Item Report - High Temperature Gas Reactor (HTGR)	ITGR)				
Project Name: Process: Estimate Number:	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O	ess Inte onia w/	egration to ASU						Client: Prepared By: Estimate Type:		M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5	r, J. Martin
Sources Considered:												
Source	Reported Capacity		Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	rrains A Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
INL Internal Cost Data (INL 2009)	-	MWth		2009	\$ 1,708,333	\$ 1,708,333	\$ 1,708,333	2,459	dWf h		\$ 4,201,101,415	\$ 4,201,101,415
Source Selected:		H		Π								
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
INL Internal Cost Data (INL 2009)	1	MWth		2009	\$ 1.708,333	\$ 1,708,333	\$ 1,708,333	2,459	MVVÆ h		\$ 4,201,101,415	\$ 4,201,101,415
Balance of Plant:												
Description	% of Total Cost	Cost		Ħ							Cost Per Train	Total Cost
Water Systems Owl/Structural/Buildings Piping Control and Instrumentation	%00.0 %00.0 %00.0										66 66 66 66 1 1 1 1	မ္မေနာ့မ္မာန္
	%-00:0						Total Balance of Plant Total Balance of Plant Plus the Selected Source	ant ant Plus the S	elected Souro		\$ \$ 4,201,101,415	\$ 4,201,101,415
Basis of Estimate Notes: Single source cost point. This cost has been privided by the subcontraded subject matter expert L. Demick to the NL NGNP Process Integration team. This cost represents a complete turnkey cost. The cost of an HTGR	as been provide	ed by th	e subcontra	cted subje	ct matter expert L.	Demick to the INL 1	NGNP Process Integ	jration team.	This cost repr	esents a complete l	tumkey cost. The co	st of an HTGR
reactor, as provided by L. Demick, is	:\$2,000,000 per	r MWth	required. T	nis cost us	ed has been reduc	ed to \$1,708,333 p	er MWth to exclude	the cost of pc	wer cycles.			

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				Ō	tail Item Report - F	Rankine Cycle - Ca	Detail Item Report - Rankine Cycle - Case 11, Supercritical PC Case	al PC Case						
Project Name: Process : Estimate Number:	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O	ress Inf nonia v	tegration //o ASU						Client: Prepared By: Estimate Typ	Client: Prepared By: Estimate Type:		M. Patterson B. Wallace, R Class 5	M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5	, J. Martin
Sources Considered:														
Source	Reported Capacity	t, e	Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train	-	Factored Cost per Train from Vormalized Cost	Total Current Cost for Required Trains
INL Internal Cost Data (INL 2009)	240	MWe	~	2009	\$ 148,362,255	\$ 148,362,255	\$ 148,362,255	618	MWe	5	176	MWe	\$ 123,069,010	\$ 615,345,051
												$\parallel$		
Summary:				]					1	1	]	1		
Source	Reported Capacity	t ed	Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
INL Internal Cost Data (INL 2009)	240	MWe	1	2009	\$ 148,362,255	\$ 148,362,255	\$ 148,362,255	879	MWe	5	176	MWe s	\$ 123,069,010	\$ 615,345,051
Balance of Plant:														
Description	% of Total Cost	Cost		Π								Ħ	Cost Per Train	Total Cost
Water Systems Civil/Structural/Buildings Pining	%00:0 %00:0													
Control and Instrumentation Electrical Systems	%00:0 %00:0	0.0.0												
							Total Balance of Plant Total Balance of Plant Plus the Selected Source	ant ant Plus the	Selected	d Source			\$ 123.069.010	\$ 615.345.051
Basis of Estimate Notes:		1		1				22	20000	5		1	2000	
Single source cost. The reported costs are from the INL project learn expert. The reported cost represents a Rankine power cycle, excluding the steam generator. The cost is based on information found in NETL 2007b, which has been adjusted and customized for this project based new cost has been adjusted and customized for this project team expert. The allowances take and exclanation found in NETL 2007b, which this project by the INL project team expert. The allowances itsted under Balance of Plant are based on NETL 2000. These allowance values are comparable to additional published estimate power such as Page 1996. The advances frame been experted and customized for this project based on NETL 2000. These allowance values are comparable to additional published estimate power cycles exists are provided in the reported cost for the Ranking power cycle cost cost for the advances frame Bowance Plantames and exclanation and prover cycle in the Ranking power cycle cost power cycle cost for the publicing that are included in the Ranking power cycle cost for the Ranking power cycle cost power cycle cost for the publicing that are included in the reported cost for the Ranking power cycle cost bower cycle cost for the reported cost for the Ranking power cycle cost for the reported cost for the Ranking power cycle cost was reported cost for the reported cost for the Ranking power cycle cost.	sts are from th or this project t 16. The allowar ter and electric	e INL pi oy the Ir noes har xal syste	oject team e VL project tex ve been adju ms BOP allo	xpert. Th am expert isted and - wances a	e reported cost repr . The allowances lis customized for this pre ire included in the re	esents a Rankine p ted under 'Balance project based on es	ower cycle, excludii • of Plant' are based stimator judgment. T Rankine power cycl	ng the stean on NETL 20 The reduced le.	n genera 00. The civil/stru	ttor. The c se allowai ctural/buili	iost is base nce values i dings allowe	d on infc are com, ance acc	ormation found in N parable to addition counts for the build	ETL 2007b, which al published ngs that are include

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Project Name: Process :	NGNP Process Integration HTSE Ammonia w/o ASU	ss Inteç nia w/o	Iration ASU	ŏ	tail Item Report -	Detail Item Report - High Temperature Steam Electrolysis (HTSE)	· Steam Electrolys	is (HTSE)	Client: Prepared Bv:	BY:	Ξ. Ξ.	M. Patterson B. Wallace, R. Honsinger, J. Martin	, J. Martin
Estimate Number: Sources Considered:	MA36-0								Estimate Type:	Type:	C	Class 5	
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains C Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
INL Feasibility Study (INL 2009)	1.00	s/b/	-	2009	\$ 36,120,156	\$ 36,120,156	\$ 36,120,156	7.51	s/64			\$ 271,216,026	\$ 271,216,03
		+	$\parallel$	$\parallel$					╢	╫	╫		
		++	$\parallel$	$\parallel$					╢	╢	╫		
Source Selected:			1						-				
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains C Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
INL Feasibility Study (INL 2009)	1.00	kg/s	-	2009	\$ 36,120,156	\$ 36,120,156	\$ 36,120,156	7.51	s/04	-		\$ 271,216,026	\$ 271,216,026
Balance of Plant:													
Description	% of Total Cost	ost	Ħ	Ħ								Cost Per Train	Total Cost
Water Systems	7.10%	+										\$ 19,256,338	\$ 19,256,338
Civil/Structural/Buildings	9.20%	H		H								\$ 24,951,874	\$ 24,951,87
Piping Control and Instrumentation	7.10% 2.60%											\$ 7.051.617	\$ 7.051.61
Electrical Systems	8.00%	$\parallel$		Ħ								\$ 21,697,282	\$ 21,697,28
		╉					Total Balance of Plant Total Balance of Plant Plue the Selected Serree	ant Diric the 4	Coloctod C	O IFOC		\$ 92,213,449 © 362,420,475	\$ 92,213,449 ¢ 363,420,475
Rationale for Selection:		1	1	1					o naisalad	20 ID		011071000 4	11,071,000 0
Single source cost. The reported costs are from the INL project team expert. The allowances listed under Balance of Plant' are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such as Page 1986.	ts are from the I	INL proje	ect team ex	pert. The	allowances listed	under 'Balance of F	lant' are based on h	VETL 2000.	These allor	vance val	nes are com	parable to additional p	ublished estimatir

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	Client: M. Patterson Prepared By: B. Wallace, R. Honsinger, J. Martin Estimate Type: Class 5		st Factored Cost Total Current Cost g Capacity Trains Capacity per Per Train from For Required Required Reqd. Train Normalized Cost Trains	5 236,902 [b/hr 1 236,902 [b/hr \$ 12,900,791 \$ 12,900,791		st Factored Cost Total Current Cost G Capacity Der PerTrain from for Required Required Reqd. Train	15 236,902 Ib/hr 1 236,902 Ib/hr \$ 12,900,791 \$ 12,900,791		Cost Per Train Total Cost	\$ 915,956 \$ 915,956	\$         1,186,873         \$         1,186,873	\$	421 \$	\$ 1,032,063 \$	\$ 4,386,269 \$ 4,386 \$ 47,000 \$ 47,000	 	Single source cost point. The allowances listed under Balance of Plant' are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such as Page 1996.	
ation	Client: Prepared By: Estimate Type:		Trains Reqd.	lb/hr 1		Trains Reqd.	lb/hr 1								otal Balance of Plant	אומורב מו בומון בתאניוה אנוא אוויכים	e comparable to additional published estimati	
Detail Item Report - N2 Generation			Norm: Reporting Year Per T Reported Cost Cost Per Train CEF	\$13,317,500 \$ 13,317,500 \$		Norm: Reporting Year Per T Reported Cost Cost Per Train CEF	\$13,317,500 \$ 13,317,500 \$								Total B		n NETL 2000. These allowance values an	
	tegration //o ASU		Report Reported Cost Trains Year Re	1 2007		Report Reported Cost Trains Year Re	1 2007									-	ance of Plant' are based or	
	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O		Reported Capacity	239,265 lb/hr		Reported Capacity	239,265 lb/hr		% of Total Cost	7.10%	9.20%	7.10%	2.60%	8.00%			vances listed under 'Bala	
	Project Name: Process: Estimate Number:	Sources Considered:	Source	N2 Generator Cost (Wood 2009)	Source Selected:	Source	N2 Generator Cost (Wood 2009)	Balance of Plant:	Description	Water Systems	Civil/Structural/Buildings	Piping	Control and Instrumentation	Electrical Systems		Rationale for Selection:	Single source cost point. The allow	

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			MA36-0						Estimate Type:	Type:	10	Class 5	*8:11011.01 .A	B. Wallace, R. Honsinger, J. Martin Class 5
Sources Considered:														
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
CO2 Compression - Subcritical Princeton Report (Kreutz 2008)	10	MM	~	2007	\$ 6,310,000	\$ 6,310,000	\$ 6,149,067	2	MΜ	-	2	\$ MM	2,329,179	\$ 2,329,179
CO2 Compression - Supercritical Princeton Report (Kreutz 2008)	13	MW	-	2007	\$ 9,520,000	\$ 9,520,000	\$ 9,277,198	0.3	Ŵ		0.3 M	\$ MW	987,887	\$ 987,887
CO2 Generation CO2 Generator (Wood 2009)	184,095 It	b/hr	-	2007	\$ 8,102,200	\$ 8,102,200	\$ 7,895,558	184,021	lb/hr	-	184,021 lb	lb/hr \$	7,893,654	\$ 7,893,654
Source Selected:		-							1	1				
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Kreutz 2008: Combined Suboritical and Supercritical Processes	Supercritical F	Processe	Se									\$	11,210,720	\$ 11,210,720
Balance of Plant:														
Description	% of Total Cost	ost										č	Cost Per Train	Total Cost
Water Systems	7.10%	+	T									6	795.961	\$ 795.961
Civil/Structural/Buildings	9.20%											60	1,031,386	\$ 1,031,386
Piping Control and Instrumentation	7.1U%												795,961	\$ /95,961 \$
Electrical Systems	8.00%	+										• ••	836,858	\$ 836,858
							Total Balance of Plant	nt :				φ.	3,811,645	\$ 3,811,645
		_					Total Balance of Plant Plus the Selected Source	int Plus the (	Selected	Source		⇔	15,022,364	\$ 15,022,364
Rationale for Selection:														
Single source cost point. The only CO2 generation source considered was Wood 2009. This cost was supplemented with CO2 compression costs from Kreutz 2008 to represent a full island cost. Both subortical and supercritical access costs wave included index the CO2 formares source sorts.	CO2 Compres	ource co	nsidered w	vas Wood	2009. This cost w	as supplemented w lance of Plant' are h	tith CO2 compression	n costs from	Kreutz 2 wance v	008 to rel	present a full	island cos to addition	t. Both subcrit	ical and supercritic
process costs were included under the ( ac Dage 1006	CO2 Compres	sion hea	adıng. Ihe	e allowanc	es listed under 'Ba	lance of Plant' are b	based on NETE 2000	). I hese allo	owance v	alues are	comparable.	to additior	ial published e	stimating guides, s

Detail Item Report - CO2 Generation

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					Det	Detail Item Report - Methanation	ethanation					
Project Name: Process : Estimate Number:	NGNP Process Integration HTSE Ammonia wo ASU MA36-O	ess Inte onia <i>wi</i> (	ASU					σ£ŭ	Client: Prepared By: Estimate Type:		M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5	r, J. Martin
Sources Considered:												
Source	Reported Capacity		Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
DOE FE Report (DOE 1978)	1,000	tpd	~	1978	\$ 1,467,000	\$ 1,467,000	\$ 3,432,834	3,360 th	tpd 1	3,360 tpd	\$ 7,103,237	\$ 7,103,237
Source Selected:												
Source	Reported Capacity		Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
DOE FE Report (DOE 1978)	1,000	tpd	1	1978	\$ 1,467,000	\$ 1,467,000	\$ 3,432,834	3,360 t	tp d	3,360 tpd	\$ 7,103,237	\$ 7,103,237
Balance of Plant:												
Description	% of Total Cost	Cost									Cost Per Train	Total Cost
Water Systems	7.10%										\$ 504,330	\$
Civil/Structural/Buildings	9.20%										\$ 653,498	\$
Piping	7.10%										\$ 504,330	<del>60</del> (
Control and Instrumentation Electrical Systems	%00% 8:00%										\$ 184,084 \$ 568,259	\$ 104,064 \$ 568,259
							Total Balance of Plant	ц			\$ 2,415,101	\$ 2,415,101
Rationale for Selection:							Total Balance of Plant Plus the Selected Source	nt Plus the Se	lected Sourc		\$ 9,518,338	\$ 9,518,338
Single source island cost identified by the project technical lead. The allowances listed under Balance of Plant are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such Page 1896.	the project tec	chnical le	ad. The all	owances	listed under 'Baland	ce of Plant' are base	ed on NETL 2000. T	hese allowand	e values are	comparable to ad	ditional published esti	mating guides, such

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					Detail It	Detail Item Report - Ammonia Synthesis	onia Synthesis							
Project Name: Process: Estimate Number:	NGNP Process Integration HTSE Ammonia w/o ASU MA36-0	ess Inte onia w/	gration o ASU						Client: Prepare Estimat	Client: Prepared By: Estimate Type:	~	M. Patterson B. Vvallace <sub>r</sub> R Class 5	M. Patterson B. Wállace, R. Honsinger, J. Martin Class 5	r, J. Martin
Sources Considered:														
Source	Reported Capacity		Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	ë ⊄	Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Vendor - Verbal 2009	360	tpd	-	2009	\$ 44,000,000	\$ 44,000,000	\$ 44,000,000	3,360	tpq	2	1,680	tpd \$	110,880,901	\$ 221,761,801
Economics Ammonia Coal Gasification (Morel 1977)		tpd	1	1977	\$ 50,748,000		69	3,360	tpq	2	1,680	tpd \$	109,546,276	\$ 219,092,551
Stamicarbon, Middle East Fertilizer Symposium, March 2009	4,297	tpd	+	2008	\$ 800,000,000	\$ 800,000,000	\$ 779,596,498	3,360	tpq	5	1,680	tpd \$	443,768,260	\$ 887,536,519
Ammonia, Chem Systems, 1998	1,653	tpd	1	1998	\$ 160,000,000	\$ 160,000,000	\$ 210,320,924	3,360		2		tpd \$	212,375,463	\$ 424,750,926
Source Selected:														
	Reported		Reported	Report Cost		Reporting Year	Normalized Cost Per Train using	Capacity	≥	Trains	Capacity per			Total Current Cost for Required
Source	Capacity		Trains	Year	Reported Cost	Cost Per Train	CEPCI Index	Required	ed	Reqd.	Train		Normalized Cost	Trains
Vendor - Verbal 2009	360	tpd	-	2009	\$ 44,000,000	\$ 44,000,000	\$ 44,000,000	3,360	tpq	2	1,680	tpd \$	110,880,901	\$ 221,761,801
Balance of Plant:														
Description	% of Total Cost	Cost		Ħ								ŭ	Cost Per Train	Total Cost
Water Svstems	7.10%	+										69	7.872.544	\$ 15.745.088
Civil/Structural/Buildings	9.20%	Ħ										\$	10,201,043	\$ 20,402,086
Piping	7.10%	+										€ <del>0</del> (	7,872,544	\$ 15,745,088
Control and instrumentation Electrical Systems	8.00%	+										e eo	2,662,305 8,870,472	\$ 17.740.944
		t					Total Balance of Plant	int					37,699,506	\$ 75,399,012
							Total Balance of Plant Plus the Selected Source	ant Plus the	Selecte	d Source		\$	148,580,407	\$ 297,160,814
Rationale for Selection:														
The verbal cost was selected as recommended by the project team expert. The Stamicarbon information shows a roughly 350% increase in prices between 2008 and 2008 emphasizing the importance of using the most recent Information available. The allowances listed under Balance of NETL 2000. These allowance values are commarzable to additional outlished estimating outders. Such as Paas 1986.	ommended by the stristed under 'B	he proje Balance	ct team exp of Plant' an	ert. The S 3 based of	Stamicarbon informs NETL 2000. Thes	ation shows a rough	nly 350% increase in s are comparable to	n prices betw additional p	veen 20 ublishe	03 and 201 d estimatin	38 emphasiz a auides. su	ing the im ch as Pac	nportance of usin ae 1996.	ig the most recent
												ĺ		

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					Detai	Detail Item Report - Urea Synthesis	a Synthesis							
Project Name: Process: Estimate Number:	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O	ess Int onia w	egration vo ASU					<u>с</u> тш	Client: Prepared By: Estimate Type:	d By: Type:	200	M. Patterson B. Wallace, F Class 5	M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5	J. Martin
Sources Considered:														
Source	Reported Capacity	גס	Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Vendor - Verbal 2009	625	tpd	F	2009	\$ 85.000.000	\$ 85.000.000	\$ 85.000.000	2.939	to q	-	2.939 t	tpd \$	215.184.342	\$ 215.184.342
Perry's Chemical Engineering Handbook, 7th Edition		tpd	-			\$ 8,800,000	\$ 12,240,152		ta pd	-			_	\$ 61,388,719
PNNL Stamicarbon, Middle East Fertilizer Swmnstium March 2009	4681 3.582	to d		2009	\$ 182,000,000 \$ 550 000 000	\$ 182,000,000 \$ 550,000,000	\$ 182,000,000 \$ 535,972,592	2,939 2,939	ta ta		2,939 t 2,939 t	tpd \$	137,653,721 475,978,115	\$ 137,653,721 \$ 475,978,115
	H			Η.						H				Ш
Source Selected:														
Source	Reported Capacity	νγ	Reporte d Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required		Trains Reqd.	Capacity per Train		Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Vendor - Verbal 2009	625	tpd	-	2009	\$ 85,000,000	\$ 85,000,000	\$ 85,000,000	2,939	tpd	-	2,939 t	tpd \$	215,184,342	\$ 215,184,342
Balance of Plant:														
Description	% of Total Cost	Cost	Π	Ħ									Cost Per Train	Total Cost
Water Systems Civil/Structural/Buildings Ploing	7.10% 9.20% 7.10%												15,278,088 19,796,959 15,278,088	5 15,278,088 5 19,796,959 5 15,278,088
Control and Instrumentation Electrical Systems	2.60%											\$	5,594,793 17,214,747	5 594,793 17,214,747
							Total Balance of Plant Total Balance of Plant Plus the Selected Source	int Plus the S	elected (	Source		€0 €0	73,162,676 288,347,019	5 73,162,676 5 288,347,019
Rationale for Selection:		1		1										
The verbal cost was selected as recommended by the project learn expert. The Stamicarbon information shows a roughly 350% increase in prices between 2003 and 2008 emphasizing the importance of using the most recent information available. The advances listed under Datance of Plant are based on NETL 2000. These advances values are comparable to additional published estimating guides, such as Fage 1950.	mmended by the listed under 'E	he proj: Balance	ect team exp e of Plant' ar	oert. The S e based o	stamicarbon informs n NETL 2000. Thes	ation shows a rough se allowance values	rly 350% increase in sare comparable to .	prices betwe additional pul	en 2003 blished ∈	and 2008 stimating	emphasizii guides, suc	ng the in ch as Pag	nportance of usin; ge 1996.	the most recent

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Project Name: NGNP Process Integration Process: HTSE Ammonia Wio ASU Estimate Number: MA36-O MA36-O Sources Considered: Reported Reported Ferrifizer Namual Ferrifizer Manual Source Selected: 33-9 tpd 1 Ferrifizer Manual Source Selected: Approved Reported Reported Source Selected: Capacity Trains	SU Su aiorted Report 1 1994 1 1998	Reported Cost 15,200,000	Leborting Year L Cost Per Train	Normalized Cost Per Train using	010	Client: Prepared By: Estimate Type:		M. Patterson B. Wallace, R. Honsinger, J. Martin Class 6	sr, J. Martin
Reported Copacity 334 tpd 334 tpd 334 capacity Copacity Copacity Capacity		Reported Cost \$ 6.600,000 \$ 15,200,000	eporting Year cost Per Train 6 600 0000 15,200,000	Vormalized Cost Per Train using					
Ince Reported Reported Capacity Control Contro Control Control Control Control Control Control Control Control		Reported Cost 5 6 600 000 5 15,200 000	eporting Year cost Per Train 6,600,000 15,200,000	Vormalized Cost Per Train using					
Fighreening 334 tpd toon 334 tpd 359 tpd 359 tpd Reported Capacity	1 1998	6,600,000 15,200,000	6,600,000	CEPCI Index	Capacity Required	Trains Regd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Reported Capacity				\$ 9,180,114 \$ 19,980,488	5,192 5,192	ی ی pq ta	865 tr 865 tr	tpd \$ 16,252,129 tpd \$ 33,851,959	\$ 97,512,774 \$ 203,111,753
Reported Capacity	-								
Reported Capacity						_		_	
	Report ported Cost ains Year	Reported Cost	l Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Fertilizer Manual 359 tpd 1	1 1998	\$ 15,200,000	\$ 15,200,000	\$ 19,980,488	5,192	tpd 6	865 tp	tpd \$ 33,851,959	\$ 203,111,753
Balance of Plant:									
Description % of Total Cost								Cost Per Train	Total Cost
Water Systems 7.10%								\$ 2,403,489	\$ 14,420,934
tructural/Buildings								\$ 3,114,380	\$ 18,686,281
Control and Instrumentation 2.60%								\$ 2,700,709	÷ 67
Electrical Systems 8.00%					-			\$ 2,708,157	\$ 16,248,940
				lotal Balance of Plant Total Balance of Plant Plus the Selected Source	nt nt Plus the S	elected Sour	8	\$ 11,509,666 \$ 45,361,625	\$ 69,057,996 \$ 272,169,749
Rationale for Selection:									
The Entilitier Manual was calarled for haine holds the newest vote route new securities. The idde from Danck Chemical Environation Handhouk is haved on earlier idde from Dataers and Timmarhaus making is used	bet noint and the	most concentrative T	ha data from Darn/	e Chamical Engined	sring Handho	olv ie haead	on earlier data fron	n Datans and Timmarhs	making it avan
The Ferritor Markuta selected for the new cost of an ure most consevate. The data not refry: Chemical Engineering reations to besed on reating and market set in the engineering reating and the selection reating and the set is addressed in reating and the set is addressed on reating and the set is a	ist point and the re based on NE	TL 2000. These allow	rie data irom Perry rance values are coi	s Unemical Enginee mparable to additio	aring manapo nal published	ok is pased estimating (	on eanier data iror luides, such as Pa	n Peters and Timmerni ge 1996.	aus, making it even
						Rimpillaco		go 1000.	

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				Detail Item F	Report - Ammoniu	Detail Item Report - Ammonium Nitrate Synthesis	6				
Project Name: Process: Estimate Number:	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O	s Integration ia w/o ASU					010	Client: Prepared By: Estimate Type:		M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5	, J. Martin
Sources Considered:											
Source	Reported Capacity	Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Perry's Chemical Engineering Handbook, 7th Edition Fertilizer Manual EPA Report	334 tp 1.395 tp 1.200 tp	tpd 1 1	1994 1998 1981	\$ 6,000,000 \$ 35,000,000 \$ 9,480,000	\$ 6,000,000 \$ 35,000,000 \$ 9,480,000	\$ 8,345,558 \$ 46,007,702 \$ 13,434,154	3,779 3,779 3,779	3 3 3 that that that that that that that tha	1,260 tpd 1,260 tpd 1,260 tpd	\$ 18,507,052 \$ 43,270,765 \$ 13,831,044	\$ 55.521.157 \$ 129.812.295 \$ 41.493.133
Source Selected:											
Source	Reported Capacity	Reported Trains	Report Cost Year	Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacity Required	Trains Reqd.	Capacity per Train	Factored Cost per Train from Normalized Cost	Total Current Cost for Required Trains
Fertilizer Manual	1,395 tp	tpd 1	1998	\$ 35,000,000	\$ 35,000,000	\$ 46,007,702	3,779	tpd 3	1,260 tpd	\$ 43,270,765	\$ 129,812,295
Balance of Plant:											
Description	% of Total Cost	st								Cost Per Train	Total Cost
Water Systems Civil/Structural/Buildings	7.10% 9.20%									\$ 3,072,224 \$ 3,980,910	\$ 9,216,673 \$ 11,942,731
Piping Control and Instrumentation	7.10%									\$ 3,072,224 \$ 1,125,040	\$ 9,216,673 \$ 3,375,120
Electrical Systems	%nn:0					Total Balance of Plant Total Balance of Plant Plus the Selected Source	Int Int Plus the Se	elected Sourc		\$         5,461,061           \$         14,712,060           \$         57,982,825	p         10, 364, 964           \$         44, 136, 180           \$         173, 948, 476
Rationale for Selection:											
The Fertilizer Manual was selected for being both the newest cost point and the most conservative. The data from Perty's Chemical Engineering Handbook is based on earlier data from Petiers and Timmenhaus, making it even less desirable. The allowances listed under Balance of Plant' are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such as Page 1996.	r being both the n under 'Balance o	newest cost poi of Plant' are bas	nt and the r sed on NETI	nost conservative. 2000. These allov	The data from Perny vance values are cu	√s Chemical Engine∉ omparable to additio	ering Handbo nal published	ok is based o estimating g	n earlier data from uides, such as Pag	Peters and Timmerha 9 1996.	us, making it even

Detail Item Report - Steam Turbines

NUCLEAD INTECDATED HVDDOCEN	Identifier:	TEV-693	
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Source Considence:         Reported Capacity         Reported Expension         Reported Reported Reported Source         Reported Reported Reported Source         Reported Reported Reported Source         Reported Reported Source         Reported Reported Source         Reported Reported Source         Reported Source         Reported Source         Reported Reported Source         Reported Source         Reported So								Prepare Estimati	Prepared By: Estimate Type:	ш О	B. Wallace Class 5	B. Wallace, R. Honsinger, J. Martin Class 5	r, J. Martin
Reported SourceReported Cost													
Steam Turtine and HFSG         Fill         Fil	eported apacity	Reported Trains		Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capacit Require		ains eqd.	Capacity pe Train		tored Cost Train from nalized Cost	Total Current Cost for Required Trains
Similacic Base Gases (NELL-2000)         193         Num         1         193         5         50,671,000         5         50,671,000         5         64,91,744         159         MV         1         150													
Steam Turbino         Stant Tu	+	-	1999	\$ 50,671,000	\$ 50,671,000	\$ 66,419,744	159	NΜ	-	_		59,899,366	\$ 59,899,36
Nincli Descent Report Z0013         401         Nincli T         2006         \$ 74,51,000         \$ 66,700,000         \$ 76,610,000	Ħ							H	Ħ				
Fillendec Report (Neutr. 2008)         215         MW         1         2001         5         65,00,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         64,3615,000         5         44,515,000         5<	1		2006	\$ 74,651,000				ΜM	<del>, _</del> -		\$ \/\	25,233,335	\$ 25,233,3
Carbon Source Selector:         230         NV         1         2006         5         44,515,000         5         4	+	-	2007	\$ 66,700,000				Ň	_		\$	46,806,721	\$ 46,806,7
Source Selected:         Reported       Reported       Cost       Reported       Cost       Reported       Case of Tail       Normalized Cost       Tails       Year       Fa         Shell IISCC Power Plant with CO2       230       MM       1       2005       \$ 44,515,000       \$ 45,619,856       159       MM       1       156       MV       \$         Shell IISCC Power Plant with CO2       230       MM       1       2005       \$ 44,515,000       \$ 45,619,856       159       MV       1       156       MV       \$         Shell IISCC Power Plant with CO2       230       M       1       2005       \$ 44,515,000       \$ 45,619,856       159       MV       1       156       MV       \$         Capacity For Netter Stell       230       N       1       2005       \$ 44,515,000       \$ 45,619,856       159       MV       1       150       MV       \$       Control       \$       Control       S		1		44,515,000	\$ 44,515,000	\$	159	MW	1			36,576,204	\$ 36,576,204
Reported SourceReported CapacityReported TrainsReported CapacityReported TrainsReported TrainReported TrainReported TrainReport TrainPer TrainReport TrainPer TrainSourceCapacityTrainsYearReported CostCapacityRequiredReqd.TrainsNorSourceCapacityTrainsYearReported CostCapacityReqd.TrainsNorSolute SoluteNor12006\$ 44,515,000\$ 44,515,000\$ 45,619,856159Nov1156NovSolute Solute230Nov12006\$ 44,515,000\$ 44,515,0													
Stantilic CC Power Plant with CO2         Control of the control	eported	Reported Trains		Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using	Capacit		ains	Capacity pe Train		tored Cost Train from	Total Current Cost for Required Trains
Shall IGCC Power Plant with C02         300         MW         1         150         150         150         150         150         150	apacity		- 40	Itebalted cost				t					
Balance of Plant:       Description       % of Total Cost       Not       Control							159	MW	-	159 N		36,576,204	\$ 36,576,204
Description         % of Total Cost         Notest Systems         Control         Cont													
Water Systems         7 10%         7 10%         8         9	Total Cost										Cos	st Per Train	Total Cost
ConvEstmental         9 20%	7 1006										4	2 506 010	\$ 2 FOR 01
Pping         7.10%         7.10%         1	9.20%										\$	3,365,011	\$ 3,365,01
Control and Instrumentation     260%     2 80%       Electrical Systems     8 00%     9       Electrical Systems     8 00%     9       Electrical Systems     8 00%     9       Rationale for Selection:     7 total Balance of Plant Plus the Selected Source     \$	7.10%										⇔	2,596,910	\$ 2,596,91
Electrical Systems 8 00% 8 101 Electrical Systems 8 00% 8 101 Electrical Systems 9 101 Electrical Systems 9 101 Electrical Selected Source 8 101 Electrical Electrical Selected Source 8 101 Electrical Electrica	2.60%										⇔	950,981	\$ 950,98
Rationale for Selection:	8.00%										\$	2,926,096	\$ 2,926,096
Rationale for Selection:						Total Balance of Pla	Int at Diversion	1.11.14.1			€-> €	12,435,909	\$ 12,435,900
Rationale for Selection:						I otal Balance of Pla	UL FIUS THE C	elected	Source		<i>~</i>	49,012,114	\$ 48'012'114
Shell IGCC PowerPlant with CO2 Canture (NET 2007b) is a recently reported cost point that closely reflects this projects requirements. The Princeton Report (Kreutz 2008) source for the stear	FT 2007b)	is a recently	reported or	ost point that closely	v reflects this project	ffs requirements Th	e Princeton F	Senort (1	reut7 20	08) source fo	r the stear	n turbine cost	point is the NFTI
are now compared with the second provide construction of the second s	alance of PI	lant' are base	d on NETL	2000. These allow	value values are co	mparable to addition	al published	estimati	ng guides	i, such as Pa	ge 1996.		
2007b report. The allowances listed under Balance of Plant' are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such as Page 1996.	alance of Pl	lant' are base	d on NETL	2000. These allow	vance values are co	mparable to addition	al published	estimati	ig guides	, such as Pa	ge 1996.		
Shell IGCC PowerPlant with CO2 Capture (NE 2007b report. The allowances listed under 'Ba		pported           0         MVV           0         MVV           0         MVV           0         MVV           0         MVV           1096         1006           0.007b         1006	ported Reported Reported Trains pacity Trains MWW 1 MWW 1 MWW 1 MWW 1 Trains ported Reported ported Reported provided Trains 10%6 10%	ported Reported Cost pecty Trains Year MWV 1 1999 MWV 1 2000 MWV 1 2000 MWV 1 2000 MWV 1 2000 MVV 1 2000 information Performance Performan	Ported ported Ported	Ported         Reported         Reported         Cost         Per Train           Ported         Trains         Year         Reported         Cost         Fer Train           PMW         1         1999         \$ 50,671,000         \$ 50,671,000         \$ 50,671,000           PMW         1         1999         \$ 74,551,000         \$ 66,700,000         \$ 66,700,000           MWW         4         2006         \$ 74,551,000         \$ 44,515,000         \$ 44,515,000           MWW         1         2006         \$ 44,515,000         \$ 64,700,000         \$ 66,700,000           MWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 44,515,000           Perted         Reported         Reported Cost         Reporting Year         \$ 10,000         \$ 14,515,000           MWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 14,515,000           MWW         1         2006         \$ 44,515,000         \$ 14,515,000         \$ 14,515,000           MWW         1         2006         \$ 44,515,000         \$ 14,515,000         \$ 14,515,000           MWW         1         2006         \$ 44,515,000         \$ 14,515,000         \$ 14,515,000	Ported         Report         Normalized Cost         Cost Per Train using           ppted         Reported         Cost         Cost Per Train using           pmW         1         199         \$ 50,671,000         \$ 66,700,000         \$ 64,998,666           mWW         1         2006         \$ 44,515,000         \$ 19,52,550         \$ 191,25,957           mWW         1         2006         \$ 66,700,000         \$ 64,398,666         \$ 44,515,000         \$ 45,519,005           mWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 44,515,000         \$ 45,519,856           mWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 45,519,856           mWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 45,519,856           mWW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 45,519,856           mported         Reported         Reported Cost         Reporting Yeer         Per Train         Cost Per Train           momalized Cost         Year         Reporting Yeer         Per Train         Cost Per Train           momalized         Year         Reporting Yeer         Per Train         Cost Per Train	Ported ported pricity         Report Train         Report (CEPCI Index         Reporting (CEPCI Index)         Normalized Cost (CEPCI Index)         Cost (CEPCI Index)         Requires (CEPCI Index)           0         MW         1         1989         \$ 50,671,000         \$ 66,419,744         150           0         MW         1         2006         \$ 74,515,000         \$ 66,700,000         \$ 66,419,744         150           0         MW         1         2006         \$ 44,515,000         \$ 66,700,000         \$ 66,700,000         \$ 150           0         MW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 44,515,000         \$ 45,619,856         150           0         MW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 44,515,000         \$ 45,619,856         150           0         MW         1         2006         \$ 44,515,000         \$ 44,515,000         \$ 45,519,856         150           0         MW         1         2006         \$ 44,515,000         \$ 45,519,856         150           0         MW         1         2006         \$ 44,515,000         \$ 45,519,856         150           0         MW         1         2006         \$	Ported         Report         Report         Report         Report         Report         Cast         Reporting Year         Normalized Cost         Tain using         Case true         Reputed         Reputed         Reputed         Reputed         Reputed         Reputed         Reputed         Reputed         Reputed         Reported         Cest Fail using         Reputed         Reputed         Reputed         Reputed         Reported         R	Ported Boticy         Report Trains         Report Cost         Report         Report         Required Required         Required Required         Required Required         Trains Required           0         MW         1         199         5         50,671,000         5         66,419,744         19         MV         1           0         MW         1         1999         5         50,671,000         5         66,419,744         19         MV         1           0         MW         1         1999         5         50,671,000         5         66,100,00         5         66,100,00         5         66,100,00         5         66,100,00         5         66,100,00         5         66,100,00         5         44,515,000         5         44,515,000         5         45,619,856         159         MW         1	ported         Report of Cost         Reported Cost<	Instruction         Report of Report of Protect         Report of Cost Per Train         Normalized Cost Reporting Vear         Normalized Cost Reporting Vear         Normalized Cost Reporting Vear         Report of Report of Protect         Capacity per Required         Fail         Normalized Report of Protect         Report of Reporting Vear         Normalized Cost Reporting Vear         Report of Report of Protect         Report of Protect         Protect         Report of Protect         Report of Protect         Report of Protect         Protect         Report of Protect         Protect         Report of Protect         Protect <td></td>	

Detail Item Report - HRSG

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Amound of the part		MA36-0	н і SE Аштопіа Wo ASU MA36-O						Client: Prepared By: Estimate Type	Client: Prepared By: Estimate Type:	Ξ m Ö	M. Patterson B. Wallace, R. Honsinger, J. Martin Class 6	nger, J. Martin	
	Sources Considered:													
Simple         Not         1         199         5         50,671,000         5         50,671,000         5         50,671,000         5         50,671,074         5         10,174          MW         1           2010         5155,913         B/hr         3         2006         5         50,671,000         5         9,471,852          MW         1         -         -         -         MW         1	Source	Reported Capacity	Reported Trains		Reported Cost	Reporting Year Cost Per Train	Normalized Cost Per Train using CEPCI Index	Capaci Require		Trains Regd.	Capacity per Train	Factored Cost per Train from Normalized Cost	st Total Current Cost m for Required ost Trains	nt Cost ired
NETL 2000)         159         MV         1         1989         5         50,671,000         5         50,671,9744         -         MV         1           2011         2013         5155         MV         1         2         2000         5         5,047,1974         -         MV         1         -         -         MV         1         -         MV	Steam Turbine and HRSG													
FIL 2017al         515.94s         Inhu         3         2006         \$         2158.05 %         5         Pun         1           2008)         355         Min         3         2006         \$         \$         \$         \$         Min         1         Min         1           2008)         555         Min         1         2006         \$         \$         \$         \$         \$         Min         1         1         Min         1	Shell IGCC Base Cases (NETL 2000)	Ħ	1	1999	\$ 50,671,000	\$ 50,671,000			NΜ	-	- W	\$ MM	69	ľ
ETL 2007al         5:155,983         thr         3         2006         \$         2/351:000         \$         9:42:1852          thrw         1         2           2006)         355         MW         1         2:007         \$         5:2:000.00         \$         9:45:3:772          thrw         1         i           2006)         8:45:301.00         \$         2:000.000         \$         2:000.000         \$         2:3:207:558          thrw         1           2001         Reported         Reported         Reported         Reported         \$         4:5:291.000         \$         2:3:207:558          thrw         1         i <td>HRSG</td> <td>+</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>t</td> <td></td> <td></td> <td></td> <td></td>	HRSG	+								t				
2008)         355         Miv         1         2007         \$         \$         200000         \$         \$         0.002100         \$         \$         0.0021000         \$         \$         0.0021000         \$         \$         0.00210000000         \$         \$         0.002100000000         \$         \$         0.002100000000000         \$         \$         0.002100000000000000000000         \$         \$         0.0021000000000000000000000000000000000	-	-	۲ 3	2006	\$ 27,581,000	\$ 9,193,667	\$ 9,421,852	•	lb/hr	-	/q  -	lb/hr \$	\$	ľ
offm CO2         8,438,000         Ib/n         2         3         3         3         3         1         Ib/n         1	-	-	1 1	2007	\$ 52,000,000	\$ 52,000,000	\$ 50,673,772		NΜ	-	- W	MWV \$	\$ 1	1
Reported Capacity         Reported Trains         Reported Vear         Reporting Vear Reporting Vear         Normalized Cost Reporting Vear Required         Trains Required         Reporting Required           vifficO2         8,336,000         Ib/hr         2         2006         \$ 22,645,500         \$ 23,207,558         -         Ib/hr         1           vifficO2         8,45,291,000         \$ 22,645,500         \$ 23,207,558         -         Ib/hr         1           vifficO3         8,0104         0         1         2         1         1         1           vifficO3         8,0104         2         2         23,207,558         -         Ib/hr         1           vifficO3         8,0104         9         1         0         1         1           vifficO3         8         0         1         1         1         1         1           vifficO4         1         1         1         1         1         1         1           vifficO4         1         1         1         1         1         1         1	it with CO2	38.000 lb/h		_		22,645,500			lb/hr	-	- ql	lb/hr \$	69	
Reported Capacity         Reported Trains         Reported Vear         Reported Reported Cost         Normalized Cost         Capacity Reported         Trains           With CO2         8.438.000         Ib/hr         2         2006         \$ 45.291.000         \$ 22.645.500         \$ 23.207.558         -         Ib/hr         1           % of Total Cost         10%         2         2006         \$ 22.645.500         \$ 23.207.558         -         Ib/hr         1           00         Ib/hr         2         2006         \$ 22.645.500         \$ 23.207.558         -         Ib/hr         1           10%         2         10%         2         2006         \$ 23.207.558         -         Ib/hr         1           0         2.006         \$ 45.291.000         \$ 22.645.500         \$ 23.207.558         -         Ib/hr         1           10%         1.0%         1         0         1         1         1         1           0         2.00%         1         1         1         1         1         1           0         2.00%         1         1         1         1         1         1	Source Selected:													
Capacity         Trains         Veal         Reported Cost         Cost Per Train         Reported         Required         Reduired		Reported	Reported			Reporting Year	Normalized Cost Per Train using	Capaci		rains	Capacity per	Factored Cost	st Total Current Cost	nt Cost ired
vith CO2         8,438,000         Ib/hr         2         2006         \$         45,291,000         \$         22,645,500           % of Total Cost         7         70%         7           7	Source	Capacity	Trains		Reported Cost	Cost Per Train	CEPCI Index	Require		Regd.	Train	-		"
% of Total Cost         %           7.10%         7.10%           9.20%         9.20%           0n         2.00%           8.00%         1	it with CO2	38,000 lb/h		2006					lb/hr	-	- ID/	lb/hr \$	\$ -	1
% of Total Cost            % of Total Cost            7 10%            9 20%            0         7 10%           2 80%            8 00%	Balance of Plant:													
01 2 50% 01 2 50% 01 2 50% 01 2 50% 01 2 50% 01 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1		of Total Cost										Cost Per Train	n Total Cost	ost
on 2.80% 10% 10% 10% 10% 10% 10% 10% 10% 10% 1														
on <u>7.10%</u> 8.00% 8.00%	Water Systems	/.10%										÷+++		1
on 2.60% 1.60\% 1.70\% 1.60\% 1.70\% 1.70\% 1.70\% 1.70\% 1.70\% 1.70\% 1.70\% 1.7	civirati ucturalraururrigs Pining	3.20%										e es	e es	
8.00%	Control and Instrumentation	2.60%										• 60	• 60	'
	Electrical Systems	8.00%										\$	\$ -	-
_							Total Balance of Pla	ant				\$	<del>69</del> -	1
Rationale for Selection:							Total Balance of Pla	ant Plus the	Selecteo	Source		\$	\$	1
	Rationale for Selection:													
Shell IGCC PowerPlant with CO2 Capture (NET - 2007b) is a recently reported cost point that dosely reflects this projects requirements. The Princeton Report (Kreutz 2008) source for the steam turbine cost point is the NETL	Shell IGCC PowerPlant with CO2 Capture (	(NET_ 2007b	) is a recently	reported or	ost point that closel	y reflects this projec	ts requirements. Th	le Princeton	Report (	Kreutz 20	08) source for	the steam turbine o	ost point is the N	ΞĽ
2000 hepdt. The allowance sits a duration of Part are based on NETL 2000. These automative structures are provided in the provided and and an and an and a structure are based on NETL 2000 hepdt. The allowance sits and and a structure structures are able and and a structure are areaded by a structure are based on NETL 2000. These and and a structure are based on NETL 2000. These and are are compared by a dotter and a structure are based on NETL 2000. These and are are compared by a dotter are based as a structure are areaded and are are areaded and a structure areaded and a structure are areaded and a structure areaded and a struct	2007b report. The allowances listed under	Balance of P	lant' are base	d on NETL	2000. These allow	ance values are col	mparable to addition	nal published	d estimat	ing guide	s, such as Pag	je 1996.		1

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	J. Martin		Total Current Cost for Required Trains	4,280,419			Total Current Cost for Required Trains	4,280,419		Total Cost	303,910	303,910	111,291 342,434	1,455,343 5,735,762		der 'Balance of Pla	]
	M. Patterson B. Wallace, R. Honsinger, J. Martin Class 5		Factored Cost To per Train from Normalized Cost	\$ 856,084 \$			Factored Cost Tc per Train from Normalized Cost	\$ 856,084 \$		Cost Per Train	\$ 60,782 \$ \$ 78.760 \$	\$ 60,782 \$	\$         22,258         \$           \$         68,487         \$	\$ 291,069 \$ \$ 1 147 152 \$	*	allowances listed unc	
			Capacity per Train	32,171 gpm			Capacity per Train	32,171 gpm								ooling towers. The	
	Client: Prepared By: Estimate Type:		rains Reqd.	gpm 2			rrains Reqd.	gpm 5						elected Source		the building of c	
	011		t g Capacity Required	8 160,853 (			st Gapacity Required	8 160,853 (						Plant Plant Plus the S	22	larly engaged in	
ling Towers			Normalized Cost Per Train using CEPCI Index	\$ 922,368			Normalized Cost Per Train using CEPCI Index	\$ 922,366						Total Balance of Plant Total Balance of Plant Plus the Selected Source	2233	am a vendor regul age 1996.	
Detail Item Report - Cooling Towers			Reporting Year Cost Per Train	\$ 922,368			Reporting Year Cost Per Train	\$ 922,368								railable cost data fro g guides, such as P	
Detai			Reported Cost	\$ 4,611,840			Reported Cost	\$ 4,611,840								ised on publically av published estimatin	
			Report Cost Year	2009			Report Cost Year	2009								al costs ba additional	
	ntegration w/o ASU		Reported Trains	ω			Reported Trains	5								ilculated capit- comparable to	
	NGNP Process Integration HTSE Ammonia w/o ASU MA36-O		Reported Capacity	182,142 gpm			Reported Capacity	182,142 gpr		% of Total Cost	7.10%	7.10%	2.60% 8.00%			le current data. Cé vance values are c	
	Project Name: Process: Estimate Number:	Sources Considered:	Source	Cooling Tower Depot		Source Selected:	Source	Cooling Tower Depot	Balance of Plant:	Description	Water Systems Civil/Sterictura/Reinidings	Piping	Control and Instrumentation Electrical Systems		Rationale for Selection:	Single source cost. Publically available current data. Calculated capital costs based on publically available cost data from a vendor regularly engaged in the building of cooling towers. The allowances listed under 'Balance of Pl are based on NETL 2000. These allowance values are comparable to additional published estimating guides, such as Page 1996.	