FINAL TECHNICAL REPORT
October 1, 2007, through September 30, 2008

Project Title: **ANALYSIS OF COAL GASIFICATION PERMITTING ISSUES IN ILLINOIS**

ICCI Project Number: 07-1/2.1C-1
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ABSTRACT

To aid developers, investors, and other parties interested in advancing integrated gasification combined cycle generating technologies ("IGCC") in the state of Illinois, the Energy Resources Center at the University of Illinois and its partners have developed an IGCC Permitting Guidebook. The intent of the IGCC Guidebook is to provide a ready reference to navigate the permitting process associated with the construction and operation of a 600-700 MWe IGCC facility utilizing Illinois coal. The Guidebook a) describes the state of the art technologies capable of utilizing Illinois coal and their associated emissions and discharge characteristics, b) details all major permitting requirements for an IGCC facility, and c) assesses the average time requirements to comply with each permitting requirement, and provides contact information for all permitting agencies in Illinois.

The Guidebook identifies a total of 16 different major permits that are required for the construction and operation of such a facility. Permits associated with the construction and operation of geological sequestration facilities, followed by air emissions permits and water permits take the longest and are the most costly. Depending on the permitting situation, acquisition of these permits can take between two to three years. The likely most costly permits include the Illinois Air Construction Permit (often totals $150,000 or more for complex projects), the Army Corps Water Related Construction Permit with Environmental Impact Statement (often totals $100,000 or more), and the carbon sequestration permit (projected to cost well in excess of $100,000 based on recent research sequestration project). These estimates include both preparation costs and filing fees.

EXECUTIVE SUMMARY

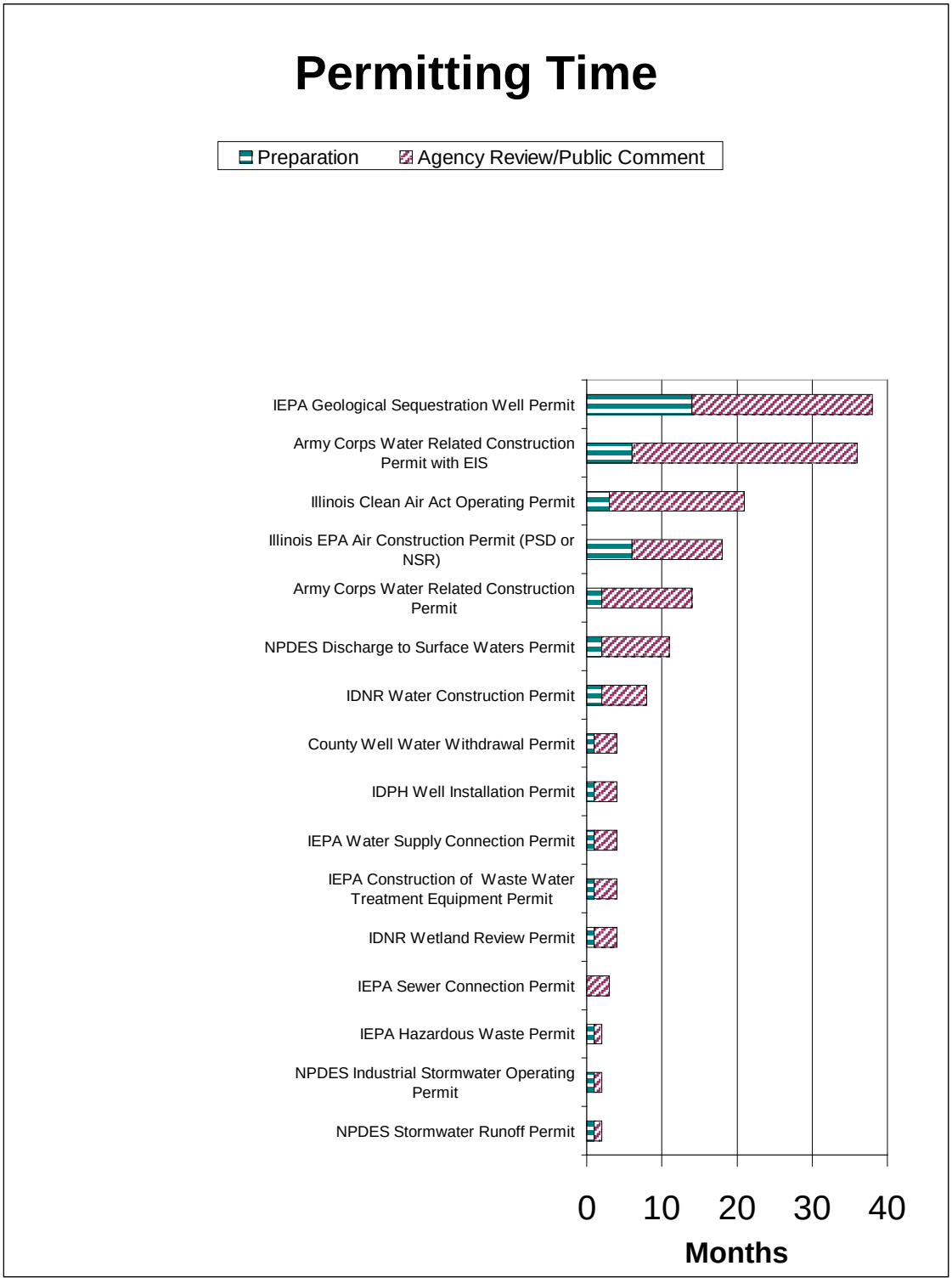
This Guidebook is intended to provide developers, investors, project managers, engineers and others interested in advancing integrated gasification combined cycle generating technologies (IGCC) in Illinois with an understanding of the basic requirements, interrelationships and early project considerations associated with acquiring the necessary permits for such a project. In terms of practical application, this guidebook focuses on examining the permitting requirements associated with the construction and operation of a nominal 600-700 MWe integrated coal gasification combined-cycle (IGCC) facility utilizing Illinois coal.

The guidebook details a total of 16 different major permits that are required for the construction and operation of such a facility. The figure below shows that the permits associated with the construction and operation of geological sequestration facilities, followed by air emissions permits and water permits take the longest to acquire. Depending on the permitting situation, acquisition of these permits can take between two to three years. The likely most costly permits include the Illinois Air Construction Permit (often total $150,000 or more for complex projects), the Army Corps Water Related Construction Permit with Environmental Impact Statement (often total $100,000 or more), and the carbon sequestration permit (have not yet been acquired in Illinois for IGCC projects, but are projected to cost well in excess of $100,000). These estimates include both preparation costs and filing fees.

Interviews with practitioners have resulted in the following recommendations which should help expedite the environmental permitting process:

- Accurately predicting the IGCC plant equipment specifications and air emissions at the beginning of the project can save substantial air permitting time and cost. In-review changes in these parameters have been known to more than double the permit acquisition time and cost of many projects.
- Regulations are continually being developed and modified. The regulations in effect at the time of project development should be discussed with the Illinois EPA.
- Review the historical Best Available Control Technology (BACT) findings on other facilities with the Illinois EPA to ensure that you account for facilities which may have not yet been published in these data.
- The air dispersion modeling protocol is one of the most important documents at the beginning of a project to avoid unnecessary delays in the project schedule.
- An ambient air monitoring protocol, while not as critical as the modeling protocol, should be submitted to the Illinois EPA at the beginning of the PSD project to avoid any misinterpretations.
- Acquire a General Stormwater Permit for Construction Site Activities early in the permitting process to initiate construction on schedule.

- Meet with local zoning authorities early in the site selection process to identify requirements for conditional use, and to evaluate the history of conditional use permitting in the area of the proposed site.



Permitting Acquisition Times

OBJECTIVES

The objective of this study is to assess all major permitting requirements associated with the construction and operation of an Integrated Gasification Combined Cycle (IGCC) facility that is located in Illinois and fueled by Illinois coal. The research effort is based on extensive input from the Illinois Environmental Protection Agency and companies currently planning or building IGCC facilities in Illinois and the US.

The work was divided into the following tasks:

- Task 1 – Create the baseline model for which the permitting requirements are evaluated. This baseline model identifies and describes those gasification technologies that are most suitable for Illinois coal. Secondly, this task identifies technologies and considerations relevant to air emissions and water discharge control as well as carbon sequestration.

- Task 2 - Research the permitting requirements for the air emissions construction and operating permit. Particular attention is given to technologies that may constitute "Best Available Control Technologies."

- Task 3 – Research the permitting requirements for water permitting including water supply and discharge considerations.

- Task 4 - Research the regulatory requirements associated with local codes and zoning approval.

- Task 5 – Research the regulatory requirements associated with the Endangered Species, Wetlands, Historic Preservation Programs and the regulatory requirements for carbon sequestration efforts.

INTRODUCTION AND BACKGROUND

This Guidebook is intended to provide developers, investors, project managers, engineers and others interested in advancing coal gasification electric generating technologies in Illinois with an understanding of the basic requirements, interrelationships and early project considerations associated with acquiring the necessary permits for such a project. In terms of practical application, this guidebook focuses on examining the permitting requirements associated with the construction and operation of a nominal 600-700 MWe integrated coal gasification combined-cycle (IGCC) facility utilizing Illinois coal. All references to IGCC systems or facilities in this Guidebook should be considered to represent that type of facility. The permitting guidebook reviews the requirements both for a new facility and a coal gasification retrofit to an existing natural gas fired plant. In addition, this guidebook examines the regulatory compliance requirements associated with potential long-term carbon sequestration efforts.

The Guidebook is segmented to review the intricate permitting requirements relating to air emissions, water usage and discharge, local codes and zoning, and other permitting requirements, including the possible permitting of a carbon dioxide (CO_2) sequestration operation. The permit application requirements and the permit approval agencies are identified, as well as important technical resources which are available to the permit applicant. The Guidebook also discusses the technologies potentially required to comply with the various impacting regulations. Finally, the Guidebook assesses the anticipated time requirements to comply with each permitting component in order to identify those permits which are likely to take the longest to acquire, bear the greatest amount of uncertainty, and bear the highest overall costs in terms of both application resources and permit authority fees.

In the discussion of permit requirements in this Guidebook, notations highlighted with the "key" symbol, as shown on the right of this paragraph, are considered to be particularly important practical aspects of project permitting to minimize the project schedule and costs.

Particularly important practical permitting considerations in this Guidebook are highlighted with the key symbol.

EXPERIMENTAL PROCEDURES

The methodology is based on personal interviews with regulators and industry experts, and a survey of the published literature.

RESULTS AND DISCUSSION

Task 1 – Create the baseline model for which the permitting requirements will be evaluated.

IGCC Technology Overview

There are three types of coals in the U.S: bituminous (also known as high-rank coal), sub-bituminous, and lignite (also known as low-rank coal). Bituminous coal has the highest heat content or calorific value (energy content per unit of weight) and lignite has the lowest energy content.[1]

Bituminous coal is the most abundant fossil fuel resource in Illinois. The sulfur content of Illinois coal, however, is much higher than that of low-rank coals found in the western states of the U.S. The high sulfur content of Illinois coal has been a limiting factor in the increased use of this natural resource.

An IGCC system is attractive for increasing the use of Illinois coal because of the greatly reduced environmental impact compared to other conventional coal combustion technologies. In addition, IGCC plants typically use 30 to 50 percent less water than pulverized coal plants. IGCC systems are also considered to be "carbon capture ready" and may be amenable to the capture and storage of carbon dioxide more easily and cost less than any of the other coal utilization options.

An IGCC system integrates two major components: coal gasification and combined-cycle power generation. The coal gasification section of an IGCC facility converts coal to a synthetic gas (syngas). The combined-cycle section of the plant combusts the syngas in combustion turbines (or gas turbines) to produce electric power. Heat in the exhaust gases of the combustion turbines is recovered to produce steam, which in turn is used to drive steam turbine(s) producing additional electric power. A general block-flow diagram of an IGCC system is shown in Figure 1.

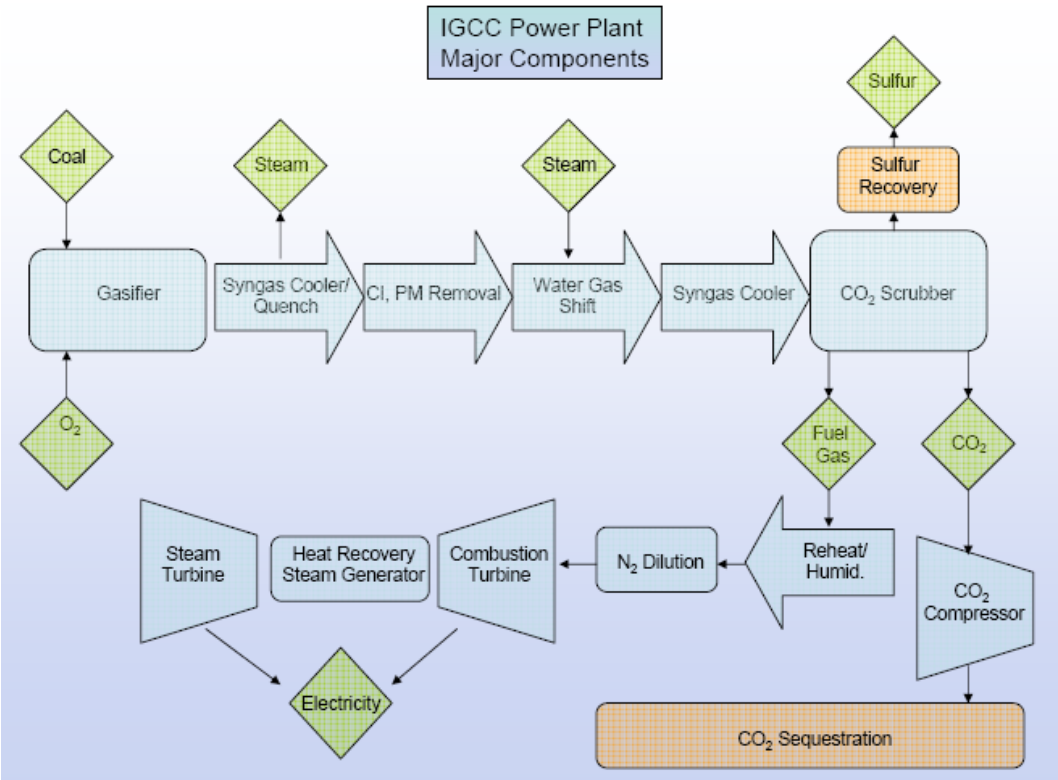


Figure 1: Schematic Diagram of an IGCC Facility

There are currently two IGCC plants generating power in the U.S. These are the the Wabash Valley Power facility in Terre Haute Indiana (http://www.wvpa.com) and the Tampa Electric Power Facility in Tampa Florida (http://www.tampaelectric.com/news/powerstation/polk/). Many new IGCC plants are undergoing development and permitting, however, and are expected to come online in many other areas of the U.S., including Illinois, in the 2012-2020 time frame.[2]

The integration of a coal gasification plant with a combined-cycle power plant is the most efficient method currently available to convert coal into electricity. An IGCC plant needs 10 to 20 percent less fuel than a large-scale conventional coal-fired power plant, and up to 35 percent less than a small-scale industrial coal fired power plant.

IGCC plants also use approximately 30 percent less water than a conventional coal-fired power plant. The gas turbines do not require cooling, which greatly reduces the amount of water required. There are typically no unusual odors or high noise levels associated with these plants.

IGCC plants are generally considerably smaller in physical size and footprint than conventional coal-fired power plants. The buildings are much smaller, with the outdoor facilities consisting of mostly vessels and pipes. The gas turbine exhaust stack is the tallest structure at the facility, but is typically much lower than the height of a conventional coal-fired power plant – often half the height of the conventional coal-fired plant stack or lower.

IGCC plants operate with minimal need for landfill waste disposal. These plants recover the ash component of the feedstock as marketable slag (solidified molten ash). Sulfur from the coal feedstock is captured as elemental sulfur and sold to the fertilizer industry for agricultural use. The mercury in the coal feedstock is captured on activated carbon, encased in steel drums and sent to regulated hazardous material processing facilities for permanent disposal. No lime scrubbers are required as in conventional pulverized coal plants. This minimization of waste products greatly reduces the burden of either constructing a local landfill, or in the case of offsite disposal reduces the impact associated with trucks hauling such materials offsite.

IGCC plants can be designed to capture CO_2 for sequestration more easily and economically than the conventional coal-fired power plants. In a conventional coal- or gas- fired power plant, CO_2 can only be removed after combustion when it has been substantially diluted with nitrogen and some oxygen. However, in IGCC plants, CO_2 may be removed before the syngas is fed to the gas turbines and captured in a more concentrated form. The movement to control CO_2 emissions in the United States is rapidly gaining support. With this fundamental carbon capture potential, IGCC becomes a most attractive option for possible CO_2 sequestration.

Specific IGCC Technologies

Several IGCC technology options are available. The primary difference among the various technology options is in the gasification technology used for the conversion of coal to syngas. The selection of gasification technology also affects the coal feed preparation system, syngas cooling, and acid gas removal.

Gasifier Technologies

There are four major types/configurations of gasifiers used for gasifying coal to syngas:

- Moving packed bed (also known as Fixed bed)
- Fluidized bed
- Transport reactor
- Entrained bed

Moving Packed Bed Gasifier: There are two types of moving packed-bed gasifiers: Dry Bottom and Slagging Bottom. In dry-bottom gasifiers, coal ash is withdrawn as dry ash. In slagging-bottom gasifiers, coal ash is withdrawn as a slag (molten ash). Lurgi in Germany is the developer of both of these types of gasifiers. The dry-bottom moving packed-bed gasifier, similar to that being used in the U.S. for a gasification plant in Great Plaines, ND for producing substitute natural gas (SNG) from a western lignite coal, is not applicable to bituminous coals because of the tendency of Illinois coal particles/lumps to stick together (agglomerate) when heated. Therefore, this technology is not further discussed in this Guidebook.

The slagging-bottom gasifier could be used for Illinois bituminous coal; however, there has not yet been an IGCC plant using moving-bed technology proposed in Illinois. Therefore, this technology is also not further discussed in this Guidebook.

Fluidized Bed and Transport Reactor Gasifiers: Several fluidized-bed and one transport-reactor gasifiers are at various stage of development and are not commercially proven for converting bituminous coals and are therefore, not further discussed in this Guidebook.

Entrained Bed Gasifiers: There are four commercially available major gasification technologies for the conversion of bituminous coal to syngas. All of these technologies use an entrained bed gasifier to react coal with oxygen and steam at temperatures high enough to produce syngas and molten ash (slag). The gasification technologies are generally being offered by the following companies:

- GE Energy
- ConocoPhillip
- Shell
- Siemens Power Systems

Specific technical features of these technologies are discussed below.

GE Energy

The GE Energy (GEE) gasification technology is an improved version of a technology originally developed by Texaco Inc. and formerly licensed by Chevron Corp.[3] The GEE technology is currently in operation at the 250 MWe Tampa Electric IGCC plant in Polk County, FL. In this system, coal-water slurry (63 percent by weight coal) is fed to the gasifier with a high-pressure pump. In the gasifier the coal slurry and oxygen (produced in a cryogenic air separation unit) react in at about 5.6 MPa (815 psia) at a high temperature, in excess of 1,316°C (2,400°F) to produce syngas. Hot syngas and molten ash (slag) produced in the gasifier flow downward into a radiant heat exchanger, where the syngas is cooled to 593°C (1,100°F) and the ash solidifies. Raw syngas continues downward into a quench system, where most of the particulate matter (PM) is removed, and then into the syngas scrubber, where most of the remaining entrained solids are removed along with ammonia. Slag captured by the quench system is recovered in a slag recovery unit. The syngas goes through a series of additional gas coolers and cleanup processes, including a carbonyl sulfide hydrolysis reactor, an activated-carbon bed for mercury (Hg) removal, and a Selexol-based acid gas removal (AGR) plant.

ConocoPhillips (CoP or E-Gas)

The ConocoPhillips (CoP) gasification technology is an improved version of the gasification technology currently in operation at the PSI Energy Inc. 265 MWe Wabash River IGCC plant near West Terre Haute, IN. This technology uses a two-stage gasifier to which coal-water slurry (63 percent by weight coal) is fed in a 78/22 ratio to the primary and secondary stages. In the primary stage of the gasifier the coal slurry and oxygen (produced in a cryogenic air separation unit) react at about 4.2 MPa (615 psia) at a about 1,371°C (2,500°F). The portion of slurry injected into the secondary stage quenches the reaction by means of endothermic gasification reactions. Gas leaving the gasifier is cooled in a fired-tube cooler producing high-pressure steam. The cooled gas is cleaned of particulate matter (PM) via a cyclone collector followed by a ceramic candle filter. The raw syngas is then further cooled before being cleaned in a spray scrubber to

remove remaining PM and trace contaminants. The syngas goes through an activated carbon bed which removes 95 percent of mercury (Hg) in the syngas. Hydrogen sulfide (H_2S) is removed from the cool, particulate-free gas stream with methyldiethanolamine solvent. Elemental sulfur is recovered in a Claus bypass-type sulfur recovery unit utilizing oxygen instead of air. The Claus plant produces molten sulfur by converting about one-third of the H_2S in the feed to sulfur dioxide (SO_2), then reacting the H_2S and SO_2 to produce sulfur and water.

Shell Technology

There is no commercial plant operating in the U.S. currently using the Shell gasification technology. In this technology dry coal is fed to the gasifier via lockhoppers. In the gasifier, the coal reacts with oxygen (produced in a cryogenic air separation unit) at about 1,427°C (2,600°F) to produce syngas. The syngas is then quenched to around 891°C (1,635°F) using cooled recycled syngas. The syngas passes through a convective cooler and leaves at a temperature near 316°C (600°F). High-pressure saturated steam is generated in the syngas cooler and is joined with the main steam supply. The syngas passes through a cyclone and a raw gas candle filter where a majority of the particulate matter is removed. The ash that is not carried out with the gas forms slag and runs down the interior walls, exiting the gasifier in liquid form (slag). The raw syngas then enters a scrubber for removal of chlorides and remaining particulate matter (PM). Following the scrubber, the raw syngas is reheated to 177°C (350°F) and fed to a Carbonyl Sulfide (COS) hydrolysis reactor where COS is catalytically converted to H_2S. The syngas is then cooled to about 35°C (95°F) before passing through a bed of activated carbon to remove 95 percent of the Hg. The Sulfinol process then removes essentially all of the CO_2 along with the H_2S and COS.

Elemental sulfur is recovered in a Claus bypass-type sulfur recovery unit utilizing O_2 instead of air. The Claus plant produces molten sulfur by converting about one-third of the H_2S in the feed to sulfur dioxide (SO_2), then reacting the H_2S and SO_2 to produce sulfur and water.

Siemens Technology

Siemens recently entered the gasification industry with its acquisition of Sustec Group's (a Swiss company) technology and engineering in May 2006. There are no commercial plants operating at this time in the U.S. using this technology. Also, there are no IGCC plants that have been proposed in Illinois using this technology.[4] There is one SNG project, however, that has been proposed using the Siemens Technology in Decatur, Illinois.

Combined-Cycle System

The combined-cycle portion of the IGCC plant consists of the following three major components:

- The Gas Turbine (GT)
- The Heat Recovery Steam Generator (HRSG)
- The Steam Turbine (ST)

The GT is fueled by the syngas produced in the gasifier. Compressed nitrogen from the air separation unit (used for producing oxygen for the gasifier) is used for syngas dilution, which aids in minimizing the formation of nitrogen oxides (NO_x) during combustion in the gas turbine combustion section. The limiting factor that determines the use of steam in the steam turbine is the maximum design pressure of 12.4 MPa (1,800 psig), which can be tolerated in the gasifier. Heat in the hot syngas from the gasifier is recovered in the HRSG and used to produce steam for the ST. The GT and ST are connected to their own electric generator. Typically, one IGCC plant would have two GTs and one ST. The two GTs produce about 60% of the total electric power and the ST generates the remaining 40%.

IGCC Plant Efficiencies and Heat Rate

The composition and characteristics of Illinois coal may vary with the location of the coal mine supplying the coal. Illinois No. 6 coal is generally well accepted as characteristic Illinois coal, with the typical composition as shown in Table 1. The overall energy efficiencies and net heat rates (energy fed to the plant as coal per kWh of the electric energy) for the GEE, CoP, and Shell processes range from 38.2 to 41.1 percent and 8,922 to 8,384 Btu/kWh and are shown in Table 2.

Table 1: Typical Composition and Heating Value (HHV) of Illinois No.6 Coal[9]

Parameter	Coal Ultimate Analysis (Wt.% As Rec'd)	Coal Ultimate Analysis (Wt.% Dry)
Moisture	11.12	0
Carbon	63.75	71.72
Hydrogen	4.50	5.06
Nitrogen	1.25	1.41
Chloride	0.29	0.33
Sulfur	2.51	2.82
Ash	9.70	10.91
Oxygen (by difference)	6.88	7.75
Total	100.0	100.0
HHV (Btu/lb)	11,666	13,126

Table 2: Typical Net Plant Energy Efficiencies and Heat Rates for the Reviewed IGCC Technologies

PROCESS	NET POWER OUTPUT, MWE	NET PLANT ENERGY EFFICIENCY, %	NET PLANT HEAT RATE (HHV), BTU/KWH
GEE	640	38.2	8,922
CoP	623	39.2	8,681
Shell	636	41.1	8,384

IGCC Plant Footprint

A typical IGCC plant for producing an approximate 600-700 MW of electric power requires about 25 to 50 acres of land.[5] The total area required depends on factors such as the topography and orientation of the plant location. This projected footprint does not include the rail loop needed for bringing coal to the IGCC plant. Since the facilities are individually designed with specific process component equipment configurations, the physical positioning of the various process components is usually specific to each plant.

IGCC Air Emission Source and Emissions Control Overview

As will be apparent in the discussion of air permitting requirements in Section 2 of this Guidebook, it is most important at the initiation of the permitting process to define the proposed emission sources and emission rates as accurately and conservatively as possible. Changes in the project that increase the predicted potential emissions after the air permit application process has been initiated will considerably impact all major components of the air permit application, and will extend the time required for the permit application preparation and review.

Generally, the air emissions in a typical IGCC plant are associated with the following plant operations:

- Coal Handling
- Sulfur Recovery
- Mercury Recovery
- Gasifier
- GT/HRSG Exhaust
- Cooling Towers
- Flare
- Auxiliary Boilers
- Emergency Generators
- Diesel-Fueled Fire-Water Pumps

The technologies used for controlling air emissions from coal handling, cooling towers, flares, auxiliary boilers, emergency generators, and diesel-fueled fire-water pumps are not impacted by their application in IGCC systems or by the IGCC technology. Therefore, the emission rates for these operations are essentially identical to those found in other coal combustion applications.

Typically, the technologies used for controlling emissions of mercury, released by coal in to the syngas, and that for reducing NO_x in the GT exhaust gases are the same for all IGCC technologies identified in this guidebook. For mercury removal from the syngas, the gas typically passes through a bed of activated carbon that removes about 95% of the mercury in the gas stream. For reducing NO_x emissions from the GT exhaust gases, the syngas is typically diluted with the compressed nitrogen, produced as a byproduct in the air separation plant for producing oxygen for the gasifier, before combustion in the GT. In addition, syngas is also humidified in the combustion section of the GT to further reduce NO_x emissions.[6]

Generally, all greenfield IGCC plants are designed to meet the environmental emissions specified in the Electric Power Research Institute's (EPRI) report on "CoalFleet User Design Basis for Coal-Based IGCC Plants Specification." The emissions control technologies used for sulfur removal, particulate matter, and mercury by the various IGCC technologies are shown in Table 3.[7,8]

In the GEE process low sulfur dioxide (SO_2) emissions (less than 4 ppmv in the flue gas) are achieved by capture of the sulfur in the Selexol Acid Gas Removal (AGR) process, which removes over 99 percent of the sulfur in the syngas. The resulting hydrogen sulfide-rich regeneration gas from the AGR system is fed to a Claus plant for producing elemental sulfur. Nitrogen oxides emissions are limited by nitrogen dilution in the gas turbine combustor to 15 ppmvd (as nitrogen oxide at 15 percent O_2). Filterable particulate matter (PM) discharge to the atmosphere is limited by the use of the syngas quench in addition to the syngas scrubber and the gas washing effect of the AGR absorber.

In the CoP process low SO_2 emissions (less than 4 ppmv in the flue gas) are achieved by capture of the sulfur in the Coastal SS Amine AGR process, which removes over 99 percent of the sulfur in the fuel gas, with final concentrations less than 30 ppmv. The resulting hydrogen sulfide-rich regeneration gas from the acid gas removal system is fed to a Claus plant, producing elemental sulfur. Nitrogen oxides emissions are limited by nitrogen dilution (primarily) and humidification (secondarily) to 15 ppmvd (as nitrogen dioxide at 15 percent O_2). Filterable PM discharge to the atmosphere is limited by a cyclone and a barrier filter in addition to the syngas scrubber and the gas washing effect of the AGR absorber.

In the Shell process, low SO_2 emissions (less than 4 ppmv in the flue gas) are achieved by capture of the sulfur in the Sulfinol-M AGR process, which removes over 99 percent of the sulfur in the fuel gas. The resulting hydrogen sulfide-rich regeneration gas from the AGR system is fed to a Claus plant, producing elemental sulfur. Nitrogen oxides emissions are limited by syngas humidification and nitrogen dilution in the gas turbine combustor to 15 ppmvd (as nitrogen oxides at 15 percent O_2). Filterable PM discharge to the atmosphere is limited by the use of a cyclone and a barrier filter in addition to the syngas scrubber and the gas washing effect of the AGR absorber.

A comparison of feeds, products and emissions of three IGCC technologies when using a typical Illinois No. 6 coal is shown in Table 4. A comparison of emissions from a typical IGCC plant with those from power plants using coal combustion and natural gas is shown in Table 5.

Table 3: Emission Control Technologies Used By Various IGCC Technologies

EMISSION SOURCE	IGCC TECHNOLOGY			
	CoP	**GEE**	**SHELL**	**SIEMENS**
Sulfur Capture	Coastal SS Amine (Two-Stage Selexol for CCS) AGR+Claus	Selexol AGR + Claus	Sulfinol-M AGR + Claus	N.A.
NO_x in the GT Exhaust	Nitrogen Dilution & Humidification in the combustor of GT	Nitrogen Dilution in the combustor of GT	Nitrogen Dilution & Humidification in the combustor of GT	N.A.
Particulate from Gasifier	Cyclone & Ceramic Candle filters	Syngas quench + syngas scrubber +gas-washing effect of the AGR absorber	Cyclone & Candle filters	N.A.
Mercury Released from Coal in Gasifier	Activated Carbon Bed	Activated Carbon Bed	Activated Carbon Bed	N.A.

Table 4: Feed, Output, and Air Emissions Summary (Illinois No. 6 Coal, 11,666 Btu/lb HHV)

PARAMETER	E-GAS	W/CCS	GE	W/CCS	SHELL	W/CCS	SIEMENS
INPUT							
Coal Feed, tons/h (tons/day)	232 (5,567)	239 (5,734)	245 (5,876)	250 (6,005)	226 (5,431)	237 (5,678)	N.A.
Air Feed to ASU, tons/hr	4,115	4,301	4,274	4,447	4,124	4,345	N.A.
Water Usage, gpm	3,757	4,135	4,003	4,579	3,792	4,563	N.A.
OUTPUT							
Net Power Output, MW	623	518	640	556	636	517	N.A.
Slag (tons/hr)	23.6	24	27	27	23	24	N.A.
ASU Vent Gas (tons/hr)	26	26	186	115	26	27	N.A.
HRSG Stack Gas, tons/h	4,339	4,219	4,347	4,219	4,364	4,219	N.A.
Sulfur, tons/h	5.8	6.0	6.1	6.3	5.7	5.9	N.A.
CO_2, tons/h	0	490		517		500	N.A.
SO_2 Emissions (ppmv)	4	3	4	3	4	3	N.A.
NO_x Emissions (ppmvd @15% O_2)	15	15	15	15	15	15	N.A.
MASS AIR EMISSIONS, tons/yr (lb/MMBtu)							
CO_2	3,777,000 (199)	460,175 (23.6)	3,937,728 (197)	401,124 (19.6)	3,693,990 (200)	361,056 (18.7)	N.A.
SO_2	237 (0.0125)		254 (0.0127)	196 (0.0096)	230 (0.0124)	204 (0.015)	N.A.
NO_x	1,126 (0.059)		1,096 (0.055)	995 (0.047)	1,082 (0.058)	944 (0.049)	N.A.
PM	135 (0.0071)		142 (0.0071)	145 (0.0071)	131 (0.0071)	137 (0.0071)	N.A.
Hg (lb/TBtu)	0.011 (0.571)		0.011 (0.571)	0.012 (0.571)	0.011 (0.571)	0.011 (0.571)	N.A.

Table 5: Comparison of Emissions from IGCC, Coal Combustion, and Natural Gas-Based Combined Cycle Power Plants[9]

POLLUTANT	IGCC	PC	NGCC
SO_2	0.0128 lb/MMBtu	0.085 lb/MMBtu	<0.6 gr $/100 scf
NO_x	15 ppmv (dry) @ 15% O2	0.07 lb/MMBtu	2.5 ppmv @ 15% O2
PM	0.0071 lb/MMBtu	0.017 lb/MMBtu	Negligible
Hg	> 90% capture	1.14 lb/TBtu	Negligible

Typical IGCC Water Outfall Overview

An IGCC plant is generally not a source of direct process-related wastewater. The typical wastewater sources which may be identified at an IGCC facility are normally associated with cooling systems and boiler operations. These are typically low-flow sources, generally containing minimal contaminants associated with water surface contact and the addition of treatment chemicals. These may include:

- Cooling tower blowdown,
- HRSG blowdown,
- Boiler feed water treatment systems,
- Treated water plant drainage system oil/water separators.

The average annual flow rates from these sources, depending on the design and size of the facility unit operations, are typically well less than 10 million gallon per day.

The quantities of sanitary wastewater associated with operation of the facility are generally small (approx. 30 gallons per day per person) and may be discharged to the local municipal sanitary sewer system or an on-site septic treatment system.

Storm water from areas of IGCC Power Station is typically routed to stormwater detention ponds and then released to approved outfalls. General plant stormwater may contact equipment, and is typically directed through an oil/water separator system. Storm water contacting the coal handling and storage areas is typically collected in detention ponds. Many coal storage and handling facilities use this water for fugitive emissions control when water spray dust suppression systems are used throughout the storage area. In these cases, the storm water is discharged only in cases of very unusual rain events when area flooding may occur. Otherwise, there is no discharge from these areas.

Carbon Capture and Sequestration Considerations

Carbon capture and storage (CCS) is an approach to mitigating global warming by capturing carbon dioxide (CO_2) from large sources such as fossil fuel power plants and storing it in geological formations rather than releasing it into the atmosphere. The technology for large-scale capture of CO_2 is already commercially available and fairly well developed. Although CO_2 has been injected into geological formations for various purposes, the long term storage of CO_2 is a relatively recent concept, and as yet no large scale power plant operates with a full carbon capture and storage system.

CCS in Conventional Power Plants

CCS applied to a modern conventional power plant could reduce CO_2 emissions to the atmosphere by approximately 80-90% compared to a plant without CCS.[1] Capturing and compressing CO_2 requires substantial energy and would increase the fuel needs of a coal-fired plant with CCS by about 25%. These and other system costs are estimated to increase the cost of energy from a new power plant with CCS by 21-91%. These estimates apply to purpose-built plants near a CO_2 storage location. Applying the technology to preexisting plants or plants far from a storage location would be more costly.

Generally, the storage of CO_2 is envisaged either in deep geological formations, in deep ocean masses, or in the form of mineral carbonates. Geological formations are currently considered the most promising sequestration sites, and these are estimated to have a storage capacity of at least 2000 Gt CO_2 (currently, 30 Gt per year of CO_2 is emitted due to human activities). IPCC estimates that the economic potential of CCS could be between 10% and 55% of the total carbon mitigation effort until year 2100.

CCS in IGCC Plants

As previously indicated, IGCC plants have an additional advantage over traditional combustion technology in that IGCC plants can be designed to capture a higher percentage of CO_2 at lower cost than conventional coal power plants. In a coal or gas fired power plant, CO_2 can only be removed after combustion, at which point the CO_2 is in relatively dilute concentrations. In IGCC plants, however, CO_2 may be removed before the syngas is fed to the gas turbines.

Task 2 - Research the permitting requirements for the air emissions permit.

In Illinois, there are two types of air permits administered by the Illinois Environmental Protection Agency (Illinois EPA), Division of Air Pollution Control: Construction Permits and Operating Permits. For new or retrofitted IGCC facilities, the Construction Permit represents the critical path to project development, construction and initial operation, while the Operating Permit is the document which provides the ongoing regulatory compliance conditions for the facility following construction. With the acquisition of an Illinois EPA Construction Permit, the facility will normally be allowed to operate for a period of up to 18 months following initial start-up, during which all permit-required emission source testing and emissions monitor verification will be conducted. In addition, the facility may prepare and submit the Illinois EPA Operating Permit application during this initial operating period.

Construction Permitting

Overview

In terms of the Construction Permit, the Illinois EPA program was established to reflect the requirements of the Federal Clean Air Act (CAA) and 1990 Amendments. It is the goal of the Construction Permit program to ensure that ambient air quality is not degraded in the area of new IGCC facilities as a result of the proposed new operation. This is achieved through a meticulous evaluation to demonstrate that the National Ambient Air Quality Standards (NAAQS) for listed pollutants can be maintained or achieved.

The CAA established two types of NAAQS for six principal pollutants, which are called "criteria" pollutants: Primary Standards which set limits to protect public health, and Secondary Standards which set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. The NAAQS as of the date of this guidebook are listed in Table 6.

The first steps in the construction permit analysis for a project are (1) to determine if the proposed IGCC project is a "major" new source or modification, and (2) to determine if the area around the proposed facility location is meeting the NAAQS for each pollutant associated with the facility. These parameters will define the required type of Construction Permit and the components of the permit application. Since an IGCC in the output range considered in the Guidebook (i.e., 600-700 MW) would generally be defined for purposes of CAA regulations as a "fossil fuel steam electric plant of more than 250 million Btu/hr heat input", the facility would be a major new emission source if located in a NAAQS attainment area, and if the potential emissions of any criteria pollutant from the facility were 100 tons/year or more. If the IGCC was a retrofit of an existing natural gas facility which was already a major source, then the retrofit would be considered a major modification if the net emissions increase of any pollutant were above the PSD significance levels indicated in Table 9.

Table 6: National Ambient Air Quality Standards

	PRIMARY STANDARDS		**SECONDARY STANDARDS**	
POLLUTANT	**LEVEL**	**AVERAGING TIME**	**LEVEL**	**AVERAGING TIME**
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour	None	
	35 ppm (40 mg/m^3)	1-hour		
Lead	1.5 ug/m^3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 ug/m^3)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM10)	150 ug/m^3	24-hour	Same as Primary	
Particulate Matter (PM2.5)	35 ug/m^3	Annual (Arithmetic Mean)	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour	Same as Primary	
	0.08 ppm (1997 std)	8-hour	Same as Primary	
	0.12 ppm	1-hour (Applies only in limited areas)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1300 ug/m3)	3-hour
	0.14 ppm	24-hour		

It the IGCC facility was to be located in an NAAQS non-attainment area, a different set of criteria and requirements would apply. The non-attainment area provisions are discussed later in this section.

Generally, based on the typical emission rates for an IGCC facility of in the 600-700 MW range, a new facility would be considered a major emission source. For example, the maximum potential emissions associated with the 770 MW Taylorville Energy Center Project proposed in Illinois are shown in Table 7.[10]

Table 7: Maximum Potential Emissions for the Taylorville Energy Center (from EPA Air Permit Application (10/06)

Pollutant	Potential Emissions (ton/year)	PSD Significant Emission Rate (tons/year)	PSD Pollutant?
Total Particulate Matter	418	25	Yes
Particulate Matter <10 um (PM10)	167	15	Yes
Sulfur Dioxide (SO_2)	391	40	Yes
Nitrogen Oxides (NO_x)	704	40	Yes
Carbon Monoxide (CO)	965	100	Yes
Volatile Organic Compounds (VOC)	32	40	No
Sulfuric Acid Mist (H2SO4)	67	7	Yes

Since a 600-700 MW IGCC facility would generally be a major emission source, if the proposed plant were to be located in an area which has been determined to have attained the NAAQS (i.e., "attainment area"), then the Construction Permit will take the form of a Prevention of Significant Deterioration (PSD) permit.

Using the Taylorville Energy Center project as an example, most of the individual criteria pollutant potential emissions would exceed the 100 tpy major source threshold for this facility. Sulfuric acid mist, while not exceeding the 100 tpy level, would also undergo major source PSD review. This is because the 100 tpy threshold would already be exceeded for the facility based on other pollutants making the facility subject to PSD review. As such, the individual sulfuric acid mist pollutant has potential emissions above the significant emission rate level for a PSD facility and is also subject to PSD review.

There are several intricate conditions of an application for PSD permit, which are summarized as follows:

Best Available Control Technology (BACT): The proposed IGCC facility would need to demonstrate that emissions will be controlled with recognized BACT levels of emission reductions. This is done through a comprehensive technical and

economic review of all commercially available emissions control methods for each source of each pollutant for which the IGCC facility is shown to be significant according to the emissions criteria in Table 9.

Air Quality Impact Evaluation: An air quality impact evaluation would need to be conducted through theoretical air modeling using recognized pollutant dispersion models. The objective would be to demonstrate that there would be no impacts above certain regulatory criteria. The impacts need to be examined for general areas surrounding the proposed facility under one set of criteria (called "Class II Areas"), and for any federally protected areas such as National Parks and Wilderness Areas (called "Class I Areas") under a more strict set of criteria. While there are no defined Class I areas in Illinois, the Illinois EPA does, on a case by case basis, consult with the Federal Land Manager of the nearest Class I areas, which are beyond 100 km. There have been relatively few Illinois projects, such as the Prairie State Generation project and Ameren Grand Tower repowering project, which have potentially impacted Class I areas in other states.

Ambient Air Monitoring Program: An ambient air quality monitoring program for up to one year in duration would need to be conducted if predicted ambient air concentrations associated with the proposed project exceed significance levels contained in Table 9. This condition may be satisfied by an evaluation of existing representative data, if available.

Additional Impacts: Impacts on soils, vegetation, crops and visibility are also required to be evaluated in the PSD review.

The PSD evaluation is only conducted, however, for pollutants for which the area has attained the NAAQS. For areas which have been determined to have not attained the NAAQS ("non-attainment areas"), a New Source Review (NSR) under the Illinois Major Stationary Sources Construction and Modification (MSSCAM) permitting requirements (35 IAC 203) apply for major new sources or modifications.

The non-attainment areas in Illinois are shown in Table 8. As indicated, the non-attainment areas are centered in counties in and around Chicago and St. Louis. The only pollutants for which these areas have not attained the NAAQS are particulate matter (PM2.5, or the <2.5 micron fraction), and ozone (note: both Volatile Organic Compounds or "VOCs" and Nitrogen Oxides or "NO_x" are regulated as ozone precursors). Given the non-attainment designations of these areas, proposed major sources in the areas would be those with the potential to emit 40 tons/year of VOC or NO_x, and 100 tons/year of PM10 (the 10 micron size fraction is used as a surrogate for the 2.5 micron fraction in Illinois)., it is apparent that an IGCC facility in the 600-700 MW range would be a major non-attainment area source of both pollutants (Table 7).

As indicated above, in Illinois the construction or modification of major emission sources in non-attainment areas is regulated under 35 IAC 203, which requires:

Lowest Achievable Emission Rate: The proposed facility must demonstrate that emission sources of the non-attainment pollutant operate using "Lowest Achievable Emission Rate (LAER)" controls, which are at least as rigorous as BACT and can be more stringent.

Emissions Offsets: The proposed IGCC facility must acquire "emissions offsets" (i.e., emissions reductions from an existing facility in the same airshed as the proposed facility) which can be applied to the proposed project. The required emissions offsets for VOC and NO_x exceed the proposed emissions levels, and must be acquired in a ratio of 1.15:1, emissions offsets:proposed emissions.

Alternatives: An analysis of any potential alternatives to the proposed IGCC project must be conducted.

Compliance Status: Information confirming that other existing major sources owned by the applicant within Illinois are in compliance with applicable air pollution regulations or on a program to come into compliance.[11]

Table 8: Current NAAQS Non-Attainment Areas in Illinois

COUNTY	NAAQS	LOCATION AND NON-ATTAINMENT CLASSIFICATION
Cook Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
Du Page Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
Grundy Co:	8-Hr Ozone *	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5 *	Chicago-Gary-Lake County, IL-IN - Nonattainment
Jersey Co:	8-Hr Ozone	St Louis, MO-IL - Moderate
Kane Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
Kendall Co:	8-Hr Ozone *	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5 *	Chicago-Gary-Lake County, IL-IN - Nonattainment
Lake Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
Madison Co:	8-Hr Ozone	St Louis, MO-IL - Moderate
	PM-2.5	St. Louis, MO-IL - Nonattainment
Mc Henry Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
Monroe Co:	8-Hr Ozone	St Louis, MO-IL - Moderate
	PM-2.5	St. Louis, MO-IL - Nonattainment
Randolph Co:	PM-2.5 *	St. Louis, MO-IL - Nonattainment
St Clair Co:	8-Hr Ozone	St Louis, MO-IL - Moderate
	PM-2.5	St. Louis, MO-IL - Nonattainment
Will Co:	8-Hr Ozone	Chicago-Gary-Lake County, IL-IN - Moderate
	PM-2.5	Chicago-Gary-Lake County, IL-IN - Nonattainment
** Part County Non Attainment Area*		

Table 9: Significant Emission Rates of Pollutants for PSD Evaluation at Major Sources or for Major Modifications

EMISSION COMPONENT	SIGNIFICANT EMISSION RATE (TONS/YEAR)
Carbon Monoxide	100
Nitrogen Oxides	40
Sulfur Dioxide	40
Particulate Matter (PM10)	15
Ozone (Volatile Organic Materials)	40
Lead	0.6
Asbestos	0.007
Beryllium	0.0004
Mercury	0.1
Vinyl Chloride	1
Fluorides	3
Sulfuric Acid Mist	7
Hydrogen Sulfide	10
Total Reduced Sulfur Compounds (including H_2S)	10

It is important to note that when an IGCC facility is proposed to be located in a non-attainment area, it may trigger PSD for the attainment pollutants and the more restrictive major source New Source Review conditions outlined above for the non-attainment pollutants. The NO_x emissions in these areas may be subject to both the PSD requirements and the MSSCAM regulations as the areas are attainment areas for NO_2 (i.e., the PSD-regulated criteria pollutant) but non-attainment areas for ozone for which total NO_x is considered a regulated precursor.

In the case where a natural gas fired plant which is an existing major air emission source may be retrofit with a coal gasification system, the starting point in the evaluation of the applicable Illinois EPA Construction Permitting requirements would be the determination of the net emissions increase attributable to the modification. If the net increase for the existing major source facility in an attainment area exceeds the levels shown in Table 9, then a PSD permit application would be required. If not, then much more simplified Illinois EPA non-major source Construction Permitting would apply, in which the BACT analysis and air quality impact evaluations would not be required. Similarly, if the facility were located in a non-attainment area, and the emissions increases were above the major modification levels for non-attainment areas indicated above, then the major modification requirements would apply. If not, then a more simplified Illinois EPA non-major source construction permit would apply.

IGCC Emissions Evaluation

At the beginning of the Construction Permitting process, it is critical with respect to permit acquisition schedule and cost that emissions be estimated for all process and fugitive emission points as definitively as possible. All other aspects of the construction permit acquisition process will build from the emissions predictions, including the BACT analyses, the ambient air quality impact analyses and the additional impact evaluations. Changes in the predicted emission source configurations and/or rates after the permit application process has begun may cause substantial components of the permit application work to be restarted. Similarly, increases in predicted emissions and changes in emission rates after the Illinois EPA permit application review has been initiated could result in the entire permit review being restarted after submission of the new information. In historical cases in which the permit review was extended well beyond normal expectations, it is often times an adjustment in emission rates or emission source configuration that causes the schedule difficulties.

Accurately predicting the IGCC plant equipment specifications and air emissions at the beginning of the project can save substantial air permitting time and cost. In-review changes in these parameters have been known to more than double the permit acquisition time of many projects.

The following methods and resources are generally used to predict air emissions from various components of IGCC facilities:

Engineering Design Specifications: for engineered process components, engineering evaluations are acceptable to the Illinois EPA.

Vendor Data and Emissions Guarantees: these are generally used to support emissions predictions for package systems, such as boilers or emergency generators, which may have applicable published emissions data and/or vendor guarantees available.

Regulatory Limits: Regulatory emissions limitations, such as those provided in New Source Performance Standards (NSPS) or other regulations, are often proposed as the basis for the maximum allowable facility emissions. When these limits are proposed they are usually supported in the permit application documents with information such as engineering specifications, mass balance calculations and published emissions factors to indicate that the regulatory limitations are viable.

USEPA Air Emission Factor References: The USEPA publishes accepted air emission factors for many types of sources, including combustion and coal processing and handling.

These factors can generally be found at:
http://www.epa.gov/ttn/chief/.

The following web link provides a no-cost on-line emission factor retrieval service:
http://cfpub.epa.gov/oarweb/index.cfm?action=fire.main.
Access to downloadable emission factor reference literature can be found at: http://www.epa.gov/ttn/chief/ap42/index.html.

For IGCC facilities, these references are particularly useful in the estimation of emission points associated with coal and slag handling, fugitive emissions associated with coal and slag storage, and fugitive emissions from roadway dust. Emission factors are also available, if needed, for various fuel combustion sources. These tend to be conservatively higher than those provided by manufacturers, however, as they need to be universally applicable to all sources regardless of manufacturing dates and technology.

Identification Of Applicable Regulations and Standards

There are a number of specific Illinois State and Federal emissions and operational regulations which would apply to a 600-700 MW IGCC facility. These regulations are summarized below. The summaries are intended to give an overview of these sometimes complex requirements. If exact detail of the regulations is required, the entire reference should be reviewed. The Federal environmental regulations are available through several resources which provide the Code of Federal Regulation (CFR) and the Federal Register (FR). These resources are linked to the USEPA Website at: http://www.epa.gov/lawsregs/index.html.

Regulations are continually being developed and modified. The regulations in effect at the time of project development should be discussed with the Illinois EPA.

The full text of the Illinois environmental regulations can be found at the Illinois Pollution Control Board website:
http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp .

Federal New Source Performance Standards (NSPS)

NSPS are a series of source-specific federal regulations that represent the minimum approvable operating and emissions specifications for the subject air emission sources. When the Construction Permit applicant is required to demonstrate that the emissions are controlled with BACT and/or LAER controls, as would be the case for a 600-700 MW IGCC facility, the final emissions control requirements will likely be more stringent than the NSPS, but may not be less stringent under any circumstances.

Standards of Performance for Electric Utility Steam Generating Units (40 CFR 60 Subpart Da)

The Subpart Da NSPS applies to "Heat recovery steam generators and the associated stationary combustion turbine(s) burning fuels containing 75 percent (by heat input) or more synthetic-coal gas on a 12 month rolling average" Since the benefit of the IGCC system is the ability to fire syngas, Subpart Da will be applicable to these facilities.

The requirements of Subpart Da include PM emission limits of 0.14 lb/MWh based on the gross energy output or 0.015 lb/MMBtu based on the coal heat input, each on a 30-day rolling average. As an alternative to meeting those limits a source may elect to limit PM in all gases to less than or equal to 0.03 lb/MMBtu based on heat input and 0.1 percent of the combustion concentration determined according to the procedures in §60.48Da(o)(5) [99.9% reduction] for facilities burning solid or solid-derived fuels. Calculations of emissions from an IGCC facility for purposes of comparison to the NSPS should be performed on the basis of coal heat input to the gasifier to be on a comparable basis to pulverized coal plants.

Recent IGCC facility permitting in Illinois and Minnesota have proposed PM emissions limitations based on their BACT evaluations that are as much as 80% below the NSPS. This indicates that BACT will be the controlling PM emissions limitation for PM from the combustion turbines rather than the NSPS.

The NO_x limitation in Subpart Da which is applicable to the combustion turbines of an IGCC is equal to 1.0 lb/MWh based on the gross energy output on a 30 day rolling average. Similar to the PM emissions limitations, the recently permitting IGCC facilities in Illinois and Minnesota have proposed and accepted BACT-based permit limitations which are, again, as much as 80% lower than the NSPS limitation, indicating that BACT is also the limiting parameter for this pollutant rather than the NSPS.

Subpart Da includes SO_2 requirements applicable to IGCC facilities which limit SO_2 emissions to below 1.4 lb/MWh based on the gross energy output; or an SO_2 concentration in the gas stream of 5 percent of the potential combustion concentration (95 percent reduction). Both of these limits are based on a 30-day rolling average. The recent IGCC facilities which have acquired PSD permits have limited the SO_2 emissions to levels which are more than an order of magnitude below the NSPS requirements as a result of the BACT determinations, indicating that BACT is the controlling limitation for SO_2 rather than the NSPS.

Mercury emissions are also limited in the Subpart Da standard to 20 lb/MWh or 0.020 lb/GWh based on a 12-month rolling average. The syngas mercury cleaning processes in the IGCC technologies described earlier in the Guidebook are designed to reliably meet this limitation, with mercury reductions well above 90%.

Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units (40 CFR 60 Subpart Db)

The requirements of 40 CFR 60 Subpart Db apply to all steam generating units that commence construction, modification, or reconstruction after June 19, 1984, and that have a heat input capacity from fuels combusted in the steam generating unit greater than 29 MW (100 million Btu/hour). The definition of coal in this regulation includes "Coal-derived synthetic fuels, including but not limited to solvent refined coal, gasified coal, coal-oil mixtures, and coal-water mixtures." This standard includes emissions limitations for SO_2, NO_x and PM, which are based on the size and configuration of the steam generating unit. This standard typically applies to auxiliary boilers in IGCC facilities.

Since the emissions limit will be based on the boiler design, this standard should be reviewed when selecting a boiler. In the recent permits for IGCC facilities in Illinois and Minnesota, the BACT analysis resulted in auxiliary boiler emissions limitations which met all of the 40 CFR 60 Subpart Db requirements.

40 CFR 60 Subpart GG – Stationary Gas Turbines

The requirements of 40 CFR Part 60 Subpart GG ("Subpart GG") apply to all stationary gas turbines with a heat input at peak load equal to or greater than 10 MMBtu/hr, based on the lower heating value of the fuel fired. The heat input to the a 600 – 700 MW IGCC facility gas turbines, at several thousand MMBtu/hr, would make the gas turbines subject to this NSPS.

Subpart GG includes an SO_2 emission limit of 0.015 percent SO_2 by volume @ 15% O_2 on a dry basis (150 ppmvd @15% O_2). There is also a NO_x requirement in Subpart GG that is applicable to units with heat inputs greater than 100 MMBtu/hr. This requirement is in the form of an emission limit for NO_x equal to 75 ppmvd @ 15% O_2 based on the following formula:

$$E = 0.0075x(\frac{14.4}{Y}) + F$$

Where:
E = allowable NO_x percent emissions at 15% 0 2 on a dry basis,
Y = heat rate at max load (kJ/Whr) but less than 14.4 kJ/Whr
F = NO_x emission allowance for fuel bound nitrogen

A review of the BACT determination for the Taylorville Energy Center project in Illinois indicates that BACT for the gas turbines at IGCC facilities will be well below the NSPS limitations, making BACT the controlling analysis.

40 CFR 60 Subpart Y – Coal Preparation Plants

The NSPS for coal preparation plants codified in 40 CFR 60 Subpart Y implements opacity limitations for operations which include crushing, screening, conveying, transferring and storage of coal, all of which would be conducted in the coal handling portion of IGCC facilities. Such emission points are subject to a 20% opacity limitation. Again, BACT-level emissions controls for these processes would be well within the Standard.

Maximum Achievable Control Technology for Major Sources of Hazardous Air Pollutants

The 1990 CAA Amendments identified specific Hazardous Air Pollutants which must be controlled at major sources using Maximum Achievable Control Technology. Major sources of HAPs are those with potential emissions of 10 tons/year of any individual HAP, and 25 tons/year of combined HAP constituents. A review of recent applications for PSD permit for IGCC facilities indicates that such facilities in the 600-700 MW range have *not* been characterized as major sources of HAPs, and are, therefore, not subject to MACT requirements.

Illinois Regulations

35 IAC 212 – Visible Emissions

Illinois regulations limit visible emissions from fuel combustion emission units to less then 20 percent opacity and less than 40 percent opacity for any three (3) minutes aggregated over any 60-minute period. Exemptions to these limits (e.g., for start up and malfunctions) are included in 35 IAC 212.124. Particulate emissions from fuel combustion emissions units, for which construction or modification commenced on or after April 14, 1972, using gaseous fuel exclusively are limited to 0.1 lb/MMBtu in any one-hour period. BACT analysis for recent IGCC facilities have proposed and accepted limits which are well below these levels.

35 IAC 216 – CO

Carbon Monoxide emissions from fuel combustion sources with actual heat input greater than 10 MMBtuIhr are limited to 200 ppm CO corrected to 50 percent excess air. BACT analysis for recent IGCC facilities have proposed and accepted limits which are well below these levels.

35 IAC 217 NO_x

For new emission sources, if the gas turbine heat input was at or above 73.2 MW (250 MMBtu/hr) the NO_x emissions would be limited to 0.310 kg/MW-hr (0.20 lbs/MMBtu) of actual heat input.

35 IAC 225 MERCURY AND NO_x

Emissions of mercury are controlled and monitored under this regulation. For coal gasification, the regulation indicates the levels of mercury will be controlled via processing of the raw fuel gas prior to combustion for removal of mercury with a system using a sorbent or other mercury control technique approved by the Illinois EPA.

Under the Illinois Clean Air Interstate Rule in 35 IAC 225, affected Electrical Generating Units, like the IGCC turbines, are required to acquire NO_x emission allowances equivalent to their NO_x emissions during the ozone season. These may be acquired through open market trading. The proposed facility will need to acquire allowances necessary to meet compliance requirements of all applicable state and federal NO_x trading programs.

35 IAC 901 - NOISE STANDARDS

The Illinois EPA noise standards limit the emission of sound during daytime hours from any property-line-noise-source which exceeds stated allowable octave band sound pressure levels. The air permit applicant generally includes a statement indicating potential noise levels and noise controls in the air permit application; although the Construction Permit will not limit noise with direct sound level specifications or other stated limitations.

BACT Analysis

An evaluation by the PSD permit applicant is required which demonstrates that all significant emission sources operate using BACT, which is defined as follows:

> *"An emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means which achieve equivalent results."*

There are four aspects of this definition which are noteworthy. First, BACT is expressed as an emission limitation based on the maximum degree of reduction of pollutants. Second, the use of the term "maximum degree of reduction" has been interpreted to support the use of a top-down analysis (i.e. consider the most stringent technology first). Third, BACT must be "available" and "applicable."' An "available" technology is one that is commercially available; meaning it has advanced through the initial research and development phase of bench scale testing, lab testing, pilot scale testing, licensing, has fully achieved commercial size demonstration and has established commercial sales without direct government subsidies. "Applicability" involves not only the commercial availability (as evidenced by past deployment on the same or similar type of emission stream) but also involves consideration of the physical and chemical characteristics of the exhaust stream to be controlled. A control method applicable to one emission source may not be applicable to a similar source depending on the differences in the physical and chemical gas stream characteristics. An applicant should be able to purchase or construct a process or control device that has already been demonstrated in practice. Fourth, the permitting agency is to consider BACT on a case-by-case basis taking into account technological feasibility, energy, environmental and economic impacts to determine whether the given technology is applicable for the project. BACT may be different at similar facilities depending on a number of facility-specific factors.

Top Down Analysis Requirements

The BACT review must be organized to review the most stringent emissions control option, and then list all other options in order of stringency. The EPA's RACT/BACT/LAER Clearinghouse can provide a starting point for investigating technology options. A comprehensive list of control options shall include inherently lower-emitting processes or work practices, add-on controls, or a combination of all of the above. In cases where effectiveness of control technology can vary considerably with expense, both options should be evaluated separately. An example is a thermal oxidizer at 90 percent efficiency versus 98 percent efficiency.

Any control option installed and successfully operated at a similar source is considered feasible. If a control has not yet been demonstrated in operation, the applicant must determine the availability. This is based on factors including commercial availability, if it realistically be installed and operated, and status in the licensing and commercial demonstration stage. The applicant can demonstrate that a control is not technically feasible by showing that it is not commercially available or that unusual circumstances prohibit its successful use. If modifications are needed to make the control compatible with the emission unit, it does not necessarily mean the control technology is technically infeasible. Such costs should be considered in the economic feasibility part of the BACT analysis.

Economic Considerations and Resources

The BACT analysis includes an evaluation of the cost of control. This is generally reported, for comparison purposes, on the basis of cost/ton of emissions control. Control technology cost evaluation specifics can be found in the USEPA OAQPS Control Cost Manual at http://www.epa.gov/ttn/catc/products.html#cccinfo. Information on interest rates for use in the calculations can be found at http://econstats.com/r/rea3.htm.

Other Resources for BACT Determination

Other resources that are available to determine the type of control technologies and the related emissions limitations for similar emission source equipment throughout the U.S. are as follows:

The USEPA RACT/BACT/LAER Clearinghouse (RBLC): The USEPA (RBLC) data base contains case-specific information on the "Best Available" air pollution technologies that have been required to reduce the emission of air pollutants from stationary sources throughout the US. This information has been provided by State and local permitting agencies. The RBLC also contains a regulation data base that summarizes EPA emission limits required in New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) standards. The database is accessible through the following USEPA website: http://cfpub.epa.gov/.

Review the historical BACT findings on other facilities with the Illinois EPA to ensure that you account for facilities which may have not yet been published in these databases.

New and Emerging Environmental Technologies (NEET) Clean Air Technologies Database: NEET is a newer on-line repository for information about technologies that prevent, remove, destroy, sample, monitor, or model air pollutant emissions. NEET contains information about technologies for improving air quality that are commercially available, as well as technologies that are currently being developed and can be a resource when conducting BACT reviews. This data base may be accessed at the following website: http://neet.rti.org/.

National Coal-Fired Utility Spreadsheet: This spreadsheet provides a summary of the characteristics, emissions and permit limitations for all major coal-fired emission sources throughout the U.S., including ICGC facilities. It can be accessed at: http://epa.gov/ttn/catc/dir1/natlcoal.xls.

National Turbine Spreadsheet: This spreadsheet provides a summary of the characteristics, emissions and permit limitations for all major turbine projects emission sources the US, including ICGC facilities. It can be accessed at: http://epa.gov/ttn/catc/dir1/natlturb.xls.

It is important to review these resources at the beginning of the BACT preparation tasks to determine what type and levels of control technology have been approved as BACT. BACT is continually changing, and the highest level of control that has been proposed by the most recent applicants will represent a current minimal level of BACT, unless the technologies are demonstrated to be technically or economically infeasible for the proposed IGCC facility.

Air Quality Impact Assessments

In PSD permitting, a complex series of air quality impact assessments must be performed to determine if the emissions associated with the proposed new IGCC facility would be acceptable. The assessments are conducted using USEPA-sanctioned atmospheric pollutant dispersion models. The models are capable of using the maximum predicted IGCC facility emissions and stack characteristics, in conjunction with available long-term meteorological records of surface and regional upper air data which are representative of the IGCC plant area, to conservatively estimate the downwind concentrations of the proposed new emissions components. Through PSD permitting, a small increase in new source contribution to the existing local ambient air concentrations of criteria pollutants is allowed. This small increase is well below the NAAQS levels, and is designed to ensure that the new source emissions contributions will not cause the NAAQS to be exceeded. This maximum allowable increase is called the “PSD Increment.” If other new sources have already contributed to (i.e. “consumed” a portion of) the available increment, then the proposed new IGCC project and the existing facility would need to be examined together to determine if they can operate simultaneously without exceeding the PSD increment. The PSD increments established in the Clean Air Act are shown in Table 10.

Table 10: PSD Increment Levels

Pollutant	Averaging Time	PSD Increment (ug/m^3)		Significant Impact Level (ug/m^3)
		Class I	Class II	
SO_2	Annual	2	20	1
	24-hour	5	91	5
	3-hour	25	512	25
	1-hour	25	512	25
PM10	Annual		17	1
	24-hour		30	5
NO_2	Annual	2.5	25	1

Significant deterioration is said to occur when the amount of new pollution would exceed the applicable PSD increment, and this would not be allowed. If this was the case, the IGCC permit applicant would need to voluntarily modify the facility plans or emissions controls until the appropriate level of impact were reached. It is important to note, however, that the air quality cannot deteriorate beyond the concentrations allowed by the applicable NAAQS, even if not all of the PSD increment is consumed.

The modeling is generally performed for each pollutant and applicable averaging time with the objectives of (i) determining the area of significant impact attributable to the proposed facility, (ii) determining the maximum ambient air concentrations attributable to the proposed facility, (iii) determining the maximum ambient air concentrations attributable to the proposed facility in conjunction with the contributions from other PSD increment consuming sources in relation to the PSD increments, and (iv) determining the maximum ambient air concentrations of the proposed source in conjunction with the largest background sources, whether PSD-consuming or not, in relation of the NAAQS.[12] The area of significant impact is determined as the radius from the proposed facility at which all concentrations are below the significance levels shown in Table 11. It will be important, in terms of the short-term averaging times, that the IGCC facility examine both the typical and process start-up emissions scenarios.

Table 11: Ambient Air Significant Impact Levels in PSD Class II Areas

Pollutant	PSD Class II Ambient Air Quality Significant Impact Levels (ug/m^3)				
	Annual	24-Hour	8-Hour	3-Hour	1-Hour
SO_2	1	5	-	25	-
PM-10	1	5	-	-	-
NO_x	1	5	-	-	-
CO	1	-	500	-	2000

Air Dispersion Model Selection and Information Resources

The air dispersion models which are used in the analysis are complex and require training in air pollution meteorology to apply effectively. Normally, the project engages an environmental consultant to assist in this effort. Background information relating to the models, as well as the executable computer source code for the USEPA-recommended models can be found at http://www.epa.gov/scram001/dispersionindex.htm.

The models are also available in Windows format for purchase from a number of environmental software vendors. Currently, the USEPA-recommended model for most typical industrial facility emissions evaluations is the AERMOD Modeling System. This is an atmospheric dispersion model capable of calculating emissions at a complex array of downwind points (i.e., "receptors") from a number of emission sources, both on-site and off-site, and for a variety of different pollutants. The model incorporates actual meteorological data as selected and input by the user, after preprocessed the data for use in the model. The model can be applied in simple terrain (i.e., relatively flat) or complex terrain (elevations exceeding stack heights) situations.

Meteorological Data Resources

The air dispersion models used in the analysis typically require a five year record of surface and upper air meteorological data. Again, original data will need to be preprocessed for use in the selected atmospheric dispersion model. Typical resources for the meteorological data are:

1. The USEPA at http://www.epa.gov/scram001/metdataindex.htm,
2. The National Data Climatic Center (NCDC) at http://www.ncdc.noaa.gov/oa/ncdc.html,
3. The various environmental meteorological data companies who sell pre-processed data, or,
4. The Illinois EPA, if there has been data submitted for the location of interest in the past.

Modeling Protocol

As indicated above, air dispersion modeling is a very complex process, and represents one of the longest scheduling components of the entire IGCC facility permitting process. This is important because it is a necessary component of Construction Permitting, which is needed prior to initiating any construction activities associated with a facility. Because air dispersion modeling is a complicated process, it is important that the applicant meet with the Illinois EPA prior to the modeling effort. Topics of discussion with the IEPA prior to modeling include model selection, meteorological data which will be used, the model options which will be used, the background PSD increment consuming sources which will be modeled with the proposed plant, the NAAQS background sources which will be modeled with the proposed plant, and other important modeling parameters. Typically, the applicant performs some cursory "screening" modeling of the proposed facility to identify the likely maximum distance from the proposed site that significant concentrations can be found. The Illinois EPA will provide source inventory information

The modeling protocol is one of the most important documents at the beginning of a project to avoid unnecessary delays in the project schedule.

for the proposed background sources to be used in the model with all of the technical information required by the model.

Prior to initiating the modeling, the applicant should prepare a formal modeling protocol to be submitted to the Illinois EPA, which includes exact specifications for the parameters discussed in the meeting. Agreement on the written protocol will help to avoid misinterpretation of modeling components.

As indicated in the introduction to the Construction Permitting section of this Guidebook, changes in emissions or emission source configurations for the project after dispersion modeling has begun can be particularly impacting on the effort, cost and completion schedule for dispersion modeling. Modeling is often an iterative process examining the impacts associated with multiple pollutants, emission sources, and averaging times. There are substantial data reduction requirements. As indicated previously, changes in the IGCC facility emission source configuration or emissions estimates after this process has begun can cause the entire process to be restarted, and this is often a source of project scheduling difficulties.

Air Quality Monitoring

Pre-construction ambient monitoring may be required for any criteria pollutant that is proposed to be emitted above the significant emission rates (or 100 tpy or more of VOCs). The Illinois EPA can exempt the applicant from this requirement if the modeled concentrations from the project are below the significant monitoring concentrations. The significant monitoring concentrations are listed below in Table 12.

Table 12: Significant Monitoring Concentrations

Pollutant	Ambient Air Concentration (ug/m^3)	Averaging Time
CO	575	8-hour
NO_2	14	Annual
SO_2	13	24-hour
PM_{10}	10	24-hour
Ozone	(100 tpy emissions increase)	Annual
Lead	0.1	3-month
Beryllium	0.001	24-hour
Mercury	0.25	24-hour
Vinyl Chloride	15	24-hour
Fluorides	0.25	24-hour
H_2S	0.2	1-hour

If the predicted concentrations are above the significant monitoring concentrations and the Illinois EPA determines that ambient air monitoring is

An ambient air monitoring protocol, while not as critical as the modeling protocol, should be submitted to the Illinois EPA at the beginning of the PSD project to avoid any misinterpretations.

required, the applicant can satisfy the requirement by either 1) establishing a site specific ambient monitoring network, or 2) using existing ambient monitoring data. Should the applicant elect to use existing ambient monitoring data, then the Illinois EPA Ambient Air Monitoring staff should be contacted regarding the use and representativeness of the existing monitoring data. The decision to accept or reject existing ambient monitoring data to meet this requirement is made by the monitoring and permitting staff. If initial agreement is reached on the applicability of existing monitoring data, the applicant should submit an ambient air monitoring protocol to the Illinois EPA discussing the intended data for use and representativeness.

It is notable that Illinois EPA has not yet processed a PSD application for which it was necessary to conduct preconstruction monitoring. In each instance the Illinois EPA has used the State monitoring network as representative monitoring sites for ambient monitoring data. IEPA has, however, required sources to conduct post construction monitoring to provide information on actual air quality after a project is in operation.[13]

The Illinois EPA operates air monitoring stations for criteria pollutants throughout the State. As would be expected, the highest concentration of monitors is in the Chicago and St. Louis NAAQS non-attainment areas; however, numerous monitors are also located in other areas as well. Monitor locations can be found at:
http://www.epa.state.il.us/air/monitoring/index.html.

At the beginning of the IGCC facility PSD permit application process, the Illinois EPA will be able to provide specific monitoring results for these stations in a number of different formats for use by the permit applicant.

Impacts Relating to Soils, Vegetation, Visibility and Regional Growth

The IGCC facility PSD permit applicant must also provide an analysis of the impacts of the proposed plant on vegetation, animals, and soils, and on emissions impacts resulting from residential and commercial growth associated with construction of the proposed plant ("additional impact analysis"). The first several steps in this process typically use modeled air concentrations and published impact screening values to evaluate exposure of flora to selected criteria pollutants (SO_2, NO_x, CO, Ozone and PM_{10}). These screening values or threshold ambient concentrations (which may indicate levels of potential adverse impacts) are evaluated for sensitive, intermediate, and resistant species.[14]

Potential adverse impacts to soil and biota from deposition of hazardous air pollutants (i.e., trace-level elements including hazardous metals) are included in the evaluation. In this stepwise process, soil (depositional) loadings calculated from annual average air concentrations (modeling results) are combined with published endogenous soil concentration data and compared against threshold impact information. Dispersion modeling results can be used evaluating the effect of trace components such as arsenic, cadmium, cobalt, selenium, chromium, fluoride, lead, manganese, mercury, and nickel. The modeled concentrations can be converted to deposited soil concentrations and plant tissue concentrations and compared against screening levels for soil, plant tissue, and dietary intake (animals).

Since the impacts are considered secondary, maximum modeled impacts for SO_2, NO_x, CO and PM_{10} should not exceed the secondary NAAQS levels set forth by USEPA Table 6. Consultation between the Illinois EPA and the Illinois Department of Natural Resources, as required under Illinois' Endangered Species Act, are typically conducted to review the permit application conclusions with respect to species of vegetation that are endangered and endangered species of animals that may be present in the area.[15] This is based on an inventory of soil types, vegetation types and endangered species of animals that may be found in the area of impact. This inventory should include all vegetation and endangered species within any commercial or recreational area. Note that it is not sufficient to state that the source impact dispersion modeling indicates concentrations below the NAAQS and, therefore, no impact is expected. The applicant also needs to verify that there are no sensitive species which could be harmed by long-term exposure to pollutant concentrations below the NAAQS.

The evaluation of impacts of the IGCC facility with respect to impairment of visibility are typically conducted using an air dispersion model which is particularly designed to address these parameters. For example, the CALPUFF model can be applied with processors that are capable of defining a daily value of light extinction by the concentrations of each pollutant that can affect visibility, taking into account the efficiency of each particle type in scattering light, and the relative humidity which influences the size of hygroscopic pollutants (sulfates and nitrates). The 24-hour average light extinction caused by emissions from the modeled source(s) is then compared to the background light extinction; a value based upon "natural" or pristine unpolluted conditions a Class I area. For IGCC facilities, the stack emissions are predominantly dilute gases and are not expected to impair visibility. Particulate emissions associated with coal handling and processing are controlled through the PSD requirements using BACT, and would not be anticipated to result in impaired visibility conditions.

The IGCC PSD Permit application also needs to include a growth projection for associated industrial, commercial or residential areas due to the proposed project, along with an estimate of air emissions from this growth. Associated growth emissions do not count towards the plant's total pollutant emissions as far as determining PSD project status, unless it is determined that an associated industrial plant qualifies as a supporting facility. Normally, the highest activity in an IGCC project takes place during the construction phase. Regional residential, commercial and industrial growth is normally not influenced to any environmentally significant extent by these projects.

Construction Permit Acquisition Timeline and Cost Considerations

Experience has shown that the recommended minimum Construction Permit acquisition time to allow for the IGCC project in the 600-700 MW range would be 18 months.[16] This would consist of a six month period for preparation of the permit application documents described above, and a one-year period for the Illinois EPA permit review, public notice, public hearing and permit issuance. This would be the minimum time required. Again, this timeline can be extended substantially if any changes to the permit application which effect facility configuration, emissions or control technology are made

during the permit review. In essence, these types of changes could cause the entire permitting effort to be restarted. Note that for the most recent IGCC permit in Illinois, the Christian County Generation facility in Taylorville, Illinois, the date of permit issuance was approximately 26 months after permit application submission, as indicated in the Permit. If the anticipated permit preparation period is included in this projection, the total time from initiation of the permitting activities would be 32 months for that permit.

In terms of permit cost, the IEPA Construction Permit project costs often total as much as $150,000 or more. This cost, again, assumes no significant changes to the project, and therefore the permit application, would be required after the initial application has been submitted to the Illinois EPA. As with the impact on permit acquisition schedule, the project costs for preparation of a modified permit application increases considerably. This is especially apparent when changes require reanalysis of the air quality impacts via dispersion modeling.

Acid Rain Permit

Pursuant to Title IV of the 1990 CAA Amendments, the EPA established a program to control emissions that contribute to the formation of acid rain. The acid rain regulations, codified under 40 CFR. Parts 72, 75 and 76 are applicable to "affected units" as defined in the regulations. A new IGCC facility in the 600-700 MW range would be classified as an affected unit under 40 CFR 72.6(a)(3), and is therefore subject to the Acid Rain Program.

As subject to the Acid Rain Program, the new IGCC facility would be required to submit an Acid Rain Permit Application to the Illinois EPA, acquire SO_2 emission allowances available through market programs, comply with NO_x emissions limitations, prepare an Acid Rain Compliance Plan, and comply with emissions monitoring requirements. Each SO_2 allowance is a limited authorization to emit up to one ton of SO_2 emissions during or after a specified calendar year.

For new units, an Acid Rain Permit application must be submitted at least 24 months prior to the date of initial operation of the unit. The application must demonstrate compliance with the Acid Rain Program requirements and include a complete compliance and monitoring plan. While not required to be part of the Illinois EPA Construction Permit application, it is suggested that the application be submitted concurrent with the Construction Permit application as the Acid Rain Permit will be more likely to be issued in a timely manner.

Affected units are required by 40 C.F.R. Part 75 to continuously monitor emissions of SO_2 and NO_x. The IGCC units are generally considered to be gas-fired for the purposes of the Acid Rain program as a result of the syngas sufur content. As a result, the IGCC units are typically exempt from opacity monitoring (40 C.F.R. 75.14(c)), may use an adjusted protocol for SO_2 monitoring using an emission factor in lieu of a continuous emissions monitor, and use an adjusted CO_2 monitoring protocol rather using an emission factor in conjunction with heat input than continuous emission monitor for CO_2.

The time required for preparation of the Acid Rain Permit application is minimal in comparison to the Construction Permit application which would generally be prepared at the same time. The application is submitted on relatively short summary permit application forms. The information needed for the forms will be generated as part of the PSD permit application information. It is estimated that the schedule for acquisition of the acid rain permit will be concurrent with that of the PSD permit, and the cost is included in that indicated above for the PSD Construction Permit.

Operating Permit

The IGCC facility would be considered a major source under Illinois Clean Air Act Permit Program (CAAPP) pursuant to Title V of the Clean Air Act as a result of being a major source under the PSD and/or non-attainment area NSR programs. A new facility would need to apply for the CAAPP permit within 18 months after initial startup of the plant. The CAAPP permit should reflect the regulatory conditions and permit limitations of the Construction Permit. The application will also include:

- Compliance certifications by a responsible facility official,
- A summary of the regulations applicable to each emission source,
- Startup, shutdown and malfunction emissions projections and information,
- Acid rain permit information,
- Compliance monitoring,
- A listing of insignificant activities at the facility, and
- Supporting data and information.

Much of the CAAPP information will be identical to information provided as background to the Construction Permit and/or included in the Construction Permit document.

This permit application would be prepared and submitted within the 18-month period following initial operation of the IGCC facility. Submission of the permit application is required for continued operation of the facility. The CAAPP permit must be renewed every five years. If no changes have taken place at the facility, the CAAPP permit can be renewed with minimal permit application forms and the incorporation by reference of historical CAAPP information.

In terms of schedule, it is estimated that the complete CAAPP Permit application may require approximately three months to prepare, and approximately 18 months for the Illinois EPA permit review and public comment period to conclude. Projected minimum cost for preparation of the permit application is $20,000. There is no permit application fee required for submission of the application. There is however, an annual site fee. The site fee is based on potential emissions of all criteria pollutants (except CO), and is invoiced at a rate of $18/ton of emissions. For a typical 600-700 MW IGCC facility, it is estimated that the minimum annual IEPA CAAPP fee would be $25,000/year.

Task 3 – Research the requirements for water permitting.

NPDES and State Water Pollution Control Permit Overview

There are two basic wastewater permit programs administered by the Illinois EPA which may be applicable to discharges from IGCC facilities: the National Pollutant Discharge Elimination System (NPDES) permit program and the State Water Pollution Control (WPC) permit program. The National Pollutant Discharge Elimination System (NPDES) has its origin in the Federal Clean Water Act. This program requires permits for the discharge of treated industrial effluent and stormwater which may come into contact with industrial operations and/or materials. The permits establish the conditions under which the discharge may occur and establish monitoring and reporting requirements. This federal program is delegated to the Illinois EPA by the USEPA.

The State WPC construction/operating permit program issues permits for the construction of new sewers, sewage pumping stations, and for connections to the public sewers which are 1500 gallon per day or larger, or serve two or more buildings. In addition, State WPC permits are required at industrial operations, such as IGCC facilities, for the construction of industrial waste pretreatment and treatment equipment.

NPDES Permits

The NPDES permit program regulates discharges to waters of the State (surface waters). There are two types of discharges controlled by NPDES permits: process wastewater and stormwater. Three kinds of NPDES permits are used to regulate such discharges, if applicable, at IGCC plants:

- NPDES Storm Water Permit for Construction Site Activities for storm water runoff,
- NPDES Storm Water Permits for Industrial Activity, also for storm water runoff; and/or,
- NPDES Permit for Waste Water Discharges to Surface Waters.

Stormwater Permit for Construction

The Clean Water Act and associated federal regulations (40 CFR 123.25(a)(9), 122.26(a), 122.26(b)(14)(x) and 122.26(b)(15)) require nearly all construction site operators engaged in clearing, grading, and excavating activities that disturb and area of one acre or more, including smaller sites in a larger common plan of development or sale, to obtain coverage under an NPDES permit for their stormwater discharges. Illinois EPA issues a general construction permit for these types of activities. The general permit can be found at: http://www.epa.state.il.us/water/forms.html#permits-wastewater .

This permit, can be commonly thought of as umbrella permit that covers all stormwater discharges associated with construction activity in Illinois for a designated time period. The current general permit expires on July 31, 2013,

Review and acquire a General Stormwater Permit for Construction Site Activities, and prepare an SWPPP early in the permitting process to initiate construction on schedule.

at which time it will likely be replaced by a renewed permit. Prior to any construction activities, an IGCC project will need to apply for coverage under this permit through submission of a Notice of Intent (NOI) to the Illinois EPA. The NOI should be submitted at least 30 days prior to the start of construction, and ideally well in advance of that point to ensure timely coverage for the project. The NOI essentially certifies that the project will agree to operate under the terms and conditions of the General Permit during the construction program. Well in advance of applying for permit coverage, therefore, the project principals should review the general permit in detail to ensure that the construction operations of the project can comply with the required permit specifications. In addition to the NOI, the facility must also develop a Stormwater Pollution Prevention Plan (SWPPP) for the construction activities. The SWPPP provides details on the elements required to prevent the contamination of stormwater runoff leaving the construction site. Detailed information on preparation of a SWPPP for construction activities can be found at: http://cfpub.epa.gov/npdes/stormwater/swppp.cfm. The construction permit should be terminated at the completion of construction to avoid unnecessary annual fees.

Stormwater Permit for Industrial Activity

Storm Water Permits for Industrial Activity may be required for IGCC plants if raw materials, finished products (or by-products), or manufacturing processes are exposed to storm water at the site. If this is the case, a Stormwater Pollution Prevention Plan will also need to be developed by the facility which discusses stormwater sources, flows, management practices to avoid contamination, emergency contact information, facility training information, and other important parameters related to the minimization of stormwater contamination. It should be noted that discharges of industrial storm water might be covered under the same permit as discharges of process and non-process wastewater.

Stormwater generated during operation of the IGCC facility is typically managed to minimize the discharge of stormwater contacting industrial activities. For example, stormwater with the potential to become impacted with process solids may be segregated from process equipment by curbs, elevated drains and other means and returned as makeup to the feedstock slurrying system or for other process water use. Stormwater that could become impacted with oil (such as runoff from parking lots) is typically routed through oil/water separators prior to being discharged off-site. Stormwater from other areas not associated with industrial activity may be routed to stormwater detention ponds where settling can occur and initial rainfall can be contained, checked, and released in a controlled manner.

Guidance on the elements and documents on the contents of SWPPPs can be found at: http://cfpub.epa.gov/npdes/stormwater/indust.cfm.

NPDES Permit for Waste Water Discharges to Surface Waters

If it is determined that a NPDES permit is required for the discharge of process and/or non-process wastewater from the proposed IGCC facility, the appropriate application forms should be submitted to Illinois EPA at least 180 days prior to the anticipated

discharge date. The application must include a complete description of the proposed source and discharge, maximum anticipated discharge concentrations of regulated components, and an antidegradation analysis. This analysis states that alternatives to and impacts of any proposed discharge have been evaluated. NPDES permits will establish pollutant limitations, monitoring requirements, and special conditions governing discharges from the IGCC facility.

The duration of NPDES permits cannot be any longer than five years. The components of the NPDES permits for the IGCC facility will depend on the design of the facility and wastewater sources. For example, in some recent IGCC facilities wastewater generated from the gasification and slag processing operations, containing certain levels of heavy metals and other contaminants from the feedstocks, are treated in Zero Liquid Discharge processes that essentially treat the process water and recover distilled water for reuse in the power plant. In these cases the contaminants are removed and treated as solid or hazardous wastes and disposed of in a regulatory appropriate manner. In these instances, no NPDES or WPC permit is required.[17]

A proposed new IGCC project should review the intended design of the facility with the Illinois EPA early in the design and planning stages to discuss the specific outfalls and to evaluate the exact effluent standards and NPDES process permitting requirements for a given facility.

The estimated minimum cost of preparing an NPDES permit application and related documents for a typical IGCC facility often totals $15,000 or more depending on the complexity of the facility and SWPPP. Individual NPDES permit fees for process and non-process discharges from IGCC facilities could range from $1,000 to $50,000 with a typical industrial facility fee being approximately $10,000 per year.

State Water Pollution Control Permit Program

The State WPC permit program regulates discharges to Publicly Owned Treatment Plants (POTWs), subsurface discharges, and land application of treated wastewater and solids (sludge). State WPC permit applications for discharges to sanitary sewers or POTWs should be submitted 45 days prior to the anticipated discharge date. A one-time permit fee can range from $1,000 to $6,000, depending on whether or not pretreatment for toxic pollutants is required. A construction permit is also necessary for construction of equipment that reduces pollutant loads either by pretreating discharge before it goes to a POTW, or treating it prior to surface or subsurface discharge. Construction permit applications for equipment that discharges to the subsurface should be submitted 90 days prior to expect discharge date, and require no fee. Construction permit applications for treatment equipment that discharges to surface waters should be submitted at the same time as the NPDES permit application. No fee is required for this permit. Discharges such as cooling tower or boiler blow down, reverse osmosis concentrates, etc. would most likely not be considered process wastewater, but would still require a State WPC permit. All necessary water permit application forms are available from the Illinois EPA website at www.epa.state.il.us/water/permits/wastewater/index.html.

Sanitary Sewers

The sanitary wastewater produced during operation of the IGCC facilities is generally small (i.e., about 30 gallons per day per person) and is either discharged to the municipal sanitary sewer system or treated in an on-site septic system. In either event, it is not anticipated that sanitary flows from and IGCC facility would need to be included in a facility NPDES permit application. If a septic system is used for the IGCC facility, the facility will need to apply to the Illinois EPA for a State Construction Permit for the system (See Section 3.1.2 above). In addition, the county in which the facility is to be located will also typically require a construction permit application for an IGCC facility septic system.

Process Water Supply Permits

Water Supply Connection Permits

Should the IGCC facility water be supplied through a connection to a public water supply, a water supply connection permit will need to be acquired from the Illinois EPA Division of Public Water Supply. This permit is actually issued to the municipal water supplier; however, in cases where the water distribution extension is dedicated to an industrial project, the permit application documents and design information are typically supplied by the project developer.

The Construction Permits must be obtained prior to beginning construction of any proposed alterations, changes or additions to an existing community water supply which may affect the sanitary quality, mineral quality or adequacy of the supply. A construction permit is not needed for less consequential work items such as:

- The installation of customer service connections to distribution system water mains already in place and designed for such connections,
- The installation or replacement of hydrants and valves in the distribution system,
- The replacement of water mains with mains of equivalent size and material in the same location, etc.

Supporting data for Construction Permit Applications includes General Information relating to the water works describing the waterworks, sewerage facilities and the municipality or area to be served. Project information describing the connections, use and other specifications will need to be supplied with the permit application. An operating permit application will need to be submitted after construction for operation of the connection.

It is estimated that the minimum total time for preparation and review of this permit application will be four months, and the minimum total cost $15,000 for the application, plans and specifications.[18]

Well Installation Permits

Should the IGCC facility require supply water from a well, an Illinois Department of Public Health (IDPH) Well Installation permit would be required prior to construction. The application for permit is submitted using forms provided by the Department or by an approved local health department. All applications for permit include a plan and drawings of the proposed well construction. At a minimum the plan must include:

- A drawing indicating lot size, direction of slope, location of property lines and distances from proposed well construction to septic tanks, abandoned wells, property lines, seepage fields, sewers, and all other sources of contamination, and an indication of the type of contamination source,
- Water well driller's license number and name,
- Estimated daily pumping capacity if greater than 100,000 gallons per day,
- the location of the water well including, county, city, street address or lot number, township, range, directions to the site (i.e., subdivision lot number, highway number, secondary roads, signs to follow, etc.), and section,
- Name and address of the owner of the well,
- Type of well to be constructed (bored, dug, drilled or driven),
- An estimate of the depth of the well,
- Type of well (i.e., non-potable use well such as industrial water well, private water well, semi-private water well, or non-community public water well), and
- The proposed aquifer.

The IDPH would deny the approval of a permit request when available information indicates that the groundwater aquifer contains contamination which exceeds the Class I groundwater standards adopted in the Groundwater Quality Standards Code (35 Ill. Adm. Code 620). A potential public health problem may be detected on the basis of a sanitary survey, laboratory analyses, location of known sources of pollution, condition of water supply, type of construction or information from previous well owners which might indicate the water would be too hazardous to drink.

It is estimated that the time required for acquisition of an IDPH water well construction permit would be four months, which includes preparation of the permit application document and IDPH review of the construction permit application. There is a minimal IDPH application fee. The minimum estimated costs for the IGCC facility permit application preparation tasks and IDPH permit application fee would be $10,000. Additional information on the IDPH well permit program can be found at: http://www.idph.state.il.us/envhealth/waterwells.htm.

Task 4 - Research the regulatory requirements associated with local codes and zoning approval.

Local zoning for a new IGCC facility is generally conducted through the county in which the facility is to be located. There are 102 counties in Illinois. The IGCC applicant should contact the local county at the inception of the project when identifying potential facility sites to determine the exact zoning ordinances and codes associated with the properties of interest for IGCC development. In most instances a Conditional Use Permit will be required for the construction of an IGCC facility.

Depending on the zoning agency, the Conditional Use Permit may review parameters such as:

- Determining if the conditional use is in harmony with the purposes, goals, objectives, policies and standards of any local Comprehensive Plan and Zoning Ordinance.
- Determining if the conditional use would cause an adverse impact on nearby property, the character of the area, environmental factors, traffic factors, parking factors or any other matters affecting public health, safety or general welfare.
- Determining if the conditional use will have an adverse impact on improvements, facilities, utilities or services provided by public agencies.
- Reviewing the potential benefits of the proposed IGCC facility in terms of receipt of additional taxes, additional employment, etc.
- Compliance of the proposed facility with other State and local regulations through other permits and approvals, such as those referenced throughout this Guidebook.

The IGCC zoning application will likely need to include property surveys, geological and wetlands surveys, and documentation to address zoning requirements. The application will be reviewed by a Zoning Board, and typically several public hearings are held to review the application and preliminary findings. The applicant will likely need to address additional considerations at several points during the evaluation.

Meet with local zoning authorities early in the site selection process to identify requirements for conditional use, and to evaluate the history of conditional use permitting in the area of the proposed site.

It is difficult to predict that time required for Conditional Use permit approval, as each zoning board and potential IGCC site location will have different conditions. In general, it is recommended that a minimum of 18 months be scheduled for this activity, given the review process and the potential for multiple public notices and hearings. The minimum anticipated cost is $40,000.

Task 5 – Research the regulatory requirements associated with the Endangered Species, Wetlands and Historic Preservation Programs as well as Programs Impacting Carbon Sequestration Efforts.

Endangered Species, Wetlands and Historic Preservation Program

For some IGCC projects it may be desirable to construct the facility adjacent to a navigable waterway, and possibly use the waterway as a potential material delivery route. In other instances the desired location of the facility may impact a wetland area, or be located in an area where levee construction would be required for the segregation of coal storage areas or other unit operations from potential flooding. In such instances both Illinois State and Federal Agency approval may be required. For this reason, a joint application program was developed between the US Army Corps of Engineers (USCOE), the Illinois Department of Natural Resources (IDNR), and the Illinois EPA for projects with proposed locations in Illinois waterways, floodplains and wetlands. Each of these agency's authorities and requirements are summarized below. Application forms are available from any of the listed agencies (i.e., identical application forms and application directions are used by all three agencies).

Anyone proposing to construct, operate or maintain any dam, dock, pier, wharf, sluice, levee, dike building, utility crossing, piling, wall, fence or other structure in, or dredge, fill or otherwise alter the bed or banks of any stream, lake, wetland, floodplain or floodway subject to State or Federal regulatory jurisdiction should apply for agency approvals. The joint application form, including a project description, engineering drawings, and any additional support information, should be submitted to each of the regulatory agencies (i.e., USCOE, IDNR and Illinois EPA). Approvals may be required by any or all of the agencies. The applications filed simultaneously with USCOE, IDNR/OWR, and the Illinois EPA will be processed concurrently, in an independent manner, and should result in expedited receipt of all agency determinations. If a permit is not required by one or more of the agencies, they will inform the applicant and other agencies of their findings.

Each agency in this program has somewhat different authorities. The IDNR has jurisdiction for the protection of the rights, safety and welfare of private and public landowners by the regulation of floodway development. Construction activities which restrict a stream's capacity to carry flood flows may result in channel instability and increased flood damages to neighboring properties. This Part applies to all rivers, lakes and streams under the Department's jurisdiction except those in the counties of Cook, Will, DuPage, Kane, Lake and McHenry. All portions of the application form, including the name and address of the applicant, a description of the proposed activity, the location of the proposed activity, and the names and addresses of all adjoining property owners, shall be completed and all required attachments must be submitted before a determination of permissibility will be made.

The Interagency Wetlands Policy Act established the Illinois goal of no overall net loss of wetlands due to state-supported activities. The act supports this goal by requiring the development of agency action plans and establishing mitigation policy. The Interagency

Wetlands Policy Act is the first regulatory program in Illinois that is dedicated solely to the protection of state wetlands. This act established the goal of no overall net loss of Illinois wetland acres or functional values due to state-supported activities. The act also required state agencies to preserve, enhance, and create wetlands as necessary in order to increase the quality of wetland resources in Illinois.

This act is implemented through the use of the State Wetlands Mitigation Policy and Agency Action Plans. The mitigation policy strongly encourages agencies to avoid impacting wetlands. If impacts are unavoidable, compensation must occur through a combination of creation, restoration, acquisition, or research projects on a least a one-to-one replacement ratio. The IDNR has responsibilities for permitting and approval under this program.

Under section 404 of the Clean Water Act, permits are required for the alteration of wetlands and for the discharge of dredged or fill material into the waters of the United States (33 CFR 323.3). (Waters of the United States includes wetlands). The Army Corps of Engineers is the permitting agency for Section 404 activities. The Secretary of the Army, acting through the Chief of Engineers, is authorized to issue the permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Selection of such sites must be in accordance with guidelines developed by the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army; these guidelines are found in Section 404(b)(1) of the Clean Water Act.

The basic form of authorization used by USCOE districts is the individual permit. Processing such permits generally involves three steps: pre-application consultation (for major projects), formal project review, and decision making. Pre-application consultation usually involves one or several meetings between an applicant, USCOE district staff, interested resource agencies (Federal, state, or local), and sometimes the interested public. The basic purpose of such meetings is to provide for informal discussions about the pros and cons of a proposal before an applicant makes irreversible commitments of resources (funds, detailed designs, etc.). The process is designed to provide the applicant with an assessment of the viability of some of the more obvious alternatives available to accomplish the project purpose, to discuss measures for reducing the impacts of the project, and to discuss the factors the USCOE must consider in its decision making process. Contact information for USCOE offices in Illinois are provided in Appendix A.

Once a complete application is received, the formal review process begins. The project manager prepares a public notice, evaluates the impacts of the project and all comments received, negotiates necessary modifications of the project if required, and drafts or oversees drafting of appropriate documentation to support a recommended permit decision. The permit decision document includes a discussion of the environmental impacts of the project, the findings of the public interest review process, and any special evaluation required by the type of activity such as compliance determinations with the Section 404(b)(1) Guidelines.

Water quality certification requirements provide an additional form of objective safeguard to the USCOE regulatory program. Section 401 of the Clean Water Act requires state certification or waiver of certification prior to issuance of a Section 404 permit. The Illinois Environmental Protection Agency provides the water quality certification pursuant to Section 401 of the Clean Water Act. This certification is mandatory for all projects requiring a Section 404 permit. In addition to determining that the proposed work will not violate the applicable water quality standards, the IEPA also makes a determination of additional permit requirements pursuant to the Illinois Pollution Control Board Rules and Regulations. As indicated in Section 4.0 of this Guidebook, additional permits may be required for activities such as the construction of sanitary sewers, water mains, sewage and water treatment plants, landfill and mining activities, special waste hauling and disposal (of dredged material), and other miscellaneous activities. Separate applications are necessary if it is determined that IEPA water permits are required.

The schedule for review and approval of the Joint Application is dependant on the type of waterway impact and permits required. In general, the minimum time for permit application preparation and review is estimated to be seven months. Permit approval by each of these agencies is subject to public notice, and potentially public hearing. If a complex permit review is required, such as when impacts include endangered species considerations or historic preservation issues, the approval time can increase. It should be noted that in the Appendix A summary the USCOE review period is indicated to be substantially longer when an Environmental Impact Statement (EIS) is required. The USCOE notes that EISs are required for "far less than one percent" of the applications. The cost associated with this permit can vary substantially with the type of permit and anticipated impacts. An estimated minimum cost for permit application preparation and permit acquisition, however, is often as much as $10,000 or more.

Carbon Sequestration Efforts

The underground injection of CO_2 into permeable geological formations, referred to as geological sequestration (GS), is a new technology and the regulatory agencies are currently adapting existing regulations to apply to this technology. Sequestration requires a method to securely deposit the material in question. In the case of CO_2, a material that is a gas at room temperature and pressure, economical sequestration requires a reduction in volume and a geologic structural trap or a stratigraphic trap with a permeable formation. The formation must be chemically compatible with CO_2 critical fluid and should not be limestone or dolomite, otherwise the injected CO_2 will dissolve the formation matrix. Further, the permeable formation must not contain or be in connection with a valuable resource, like potable groundwater. Examples of appropriate formations may include: saline aquifers, oil reservoirs and coal seams.

Under current Illinois regulations, the Underground Injection Permit Application is an iterative process within the Illinois EPA and may include the IDNR Oil & Gas Division and/or the Illinois Commerce Commission (ICC). The IEPA is the primary permitting agency, the IDNR would be involved if injection is into an oil reservoir and the ICC would be involved if the transportation pipeline from the facility to the injection well is a

common carrier or if eminent domain is required to construct the transportation pipeline. The Underground Injection Permit includes the injection wells, in-zone monitoring wells in the injected formation and regulatory monitoring wells in the lowest underground source of drinking water.[19]

On July 25, 2008, the U.S. EPA published draft regulations that would apply to GS injection wells. This section provides an overview of the existing regulations and a brief summary of the regulations proposed by U.S. EPA. In general, regulations have been promulgated to control two (2) separate activities associated with GS: the injection of the CO_2 into the geological formation and the transport of the carbon dioxide from the power plant to the injection wells.

Underground Injection Wells

Most underground injection wells, including those used for CO_2 sequestration, must be permitted by the Illinois EPA. The only exception is injection wells used to enhance recovery of oil or natural gas. These recovery enhancement injection wells are regulated by the IDNR. The regulations governing the permitting of underground injection wells are found in Title 35 Part 702 and 704 of the Illinois Administrative Code. The design and permitting requirements for underground injection wells depend on the classification of the injection well. There are only five (5) permitted injection wells within the State of Illinois.

IEPA has five (5) classifications of injection wells, some of which will not apply to CO_2 sequestration. The following list only contains the examples of injection wells within each Class that may be part of an IGCC process.

Class I - Includes two types of wells:
a) An industrial disposal well that injects fluids beneath the lowermost formation containing an Underground Source of Drinking Water (USDW) within ¼ mile of the injection well.

b) A well used to inject hazardous waste beneath the lowermost formation containing an Underground Source of Drinking Water (USDW) within ¼ mile of the injection well.

Class II - A well in which fluids are injected for the enhanced recovery of oil or natural gas. This class of injection well is regulated by the Illinois Department of Natural Resources (IDNR).

Class III - A well that injects fluids for the extraction of minerals, such as sulfur. This class generally will not apply to IGCC projects.

Class IV - This class applies to wells used for the disposal of hazardous or radioactive waste. This class is prohibited in the State of Illinois.

Class V - Any injection well that is not classified as Class I, II, III or IV.

Generally, injection wells associated with the IGCC process may be Class I, II, or V, depending on the locations or use of the injection wells. If the injection well is located within ¼ mile of a USDW, that well will be Class I. If the CO_2 is used to enhance the recovery of oil or natural gas, the well will be Class II. All other injection wells for CO_2 sequestration would, under existing regulations, be classified as Class V. An area permit can be obtained for more than one (1) injection well if the injection wells are located in the same well field.

An important consideration in CO_2 injection, and one that can easily be overlooked, is the concentration of trace materials in the CO_2, such as mercury, arsenic, other metals, and trace organic compounds. The concentration of these materials can vary widely depending on the source of the coal and the air control devices used for the IGCC process. The injection of CO_2 is subject to disposal regulations, including the Resource Conservation and Recovery Act (RCRA). The CO_2 stream to be injected must be tested in accordance with Title 35 Part 721 of the Illinois Administrative Code. If the concentration of any chemical exceeds its Maximum Concentration Limit (MCL) found in Title 35 Part 721 of the Illinois Administrative Code, the injection of the CO_2 must be performed in accordance with the hazardous waste regulations found in Title 35 Parts 720-729 of the Illinois Administrative Code.

Under current Illinois regulations, the preparation of the Underground Injection Permit Application requires descriptions of the area geology, the well construction materials, proposed depths of the injection and monitoring wells, a groundwater monitoring program and a mechanical integrity testing program. Additionally, the Underground Injection Permit Application requires a demonstration that no hazardous constituents will be included in the CO_2 stream at concentrations greater than their respective MCLs, and a calculation of the capacity of the formation that will receive the injection. This capacity calculation requires an understanding of the materials and permeability of the formation to be injected. The performance of the particular formation at the proposed injection site may not be known and therefore, must be estimated based upon information from the nearest well drilled into said formation.

The number of injection wells required to handle the volume of CO_2 produced by the IGCC plant is a function of flow rates, well diameter, formation permeability and formation capacity. The number of in-zone monitoring wells is a function of the calculated plume size and thickness of the formation to be injected. The number of regulatory monitoring wells in the lowest underground source of drinking water is also a function of the calculated plume size and the location of the lowest underground source of drinking water.

The recent proposed US EPA draft regulations (July 25, 2008) would apply only to GS injection wells that would not be regulated as Class I or Class II injection wells (Federal Register Volume 73, Number 144 page 43492). When finalized, the regulations will be incorporated into the Code of Federal Regulations Title 40 Part 144 and 146. If a GS well was within ¼ mile of a USDW it would continue to be regulated as a Class I well and if it was used to extract oil or natural gas, it would continue to be regulated as a Class

II well. All other GS injection wells would be Class VI. The comment period for these proposed regulations ends on November 24, 2008. It typically takes several years between the first proposed regulations and the final regulations. The permitting requirements in the final regulations may be substantially different than the proposed permitting requirements.

Illinois EPA's current requirements for Class I injection wells are very similar to U.S. EPA's proposed requirements for Class VI injection wells. The major difference is the Area of Review, which currently is a ¼ mile radius (0.05 square miles). Under the proposed regulations, the Area of Review will be determined by computer modeling and is expected to encompass several square miles. This significantly larger Area of Review will increase the number of monitoring wells, the number of wells, springs and USDWs within the Area of Review, and potential corrective action costs.

An Illinois licensed Professional Engineer must sign and stamp the Underground Injection Permit Application, and must be familiar with the preparation of each component of the application. Other experts required for the preparation of the permit application include: geologists, hydrogeologists, drilling contractors, environmental engineers and mechanical engineers.

The IEPA reviews permit applications for injection wells in on a case-by-case basis and there are no regulatory deadlines for this review. The regulations do require that IEPA develop a schedule for the permit review process. The IEPA will likely require clarification of some components of the permit application. However, as the IEPA, industrial users and consultants gain experience with this process, the number of iterations should be reduced. The time required for IEPA review of the permit application is undetermined. Upon approval of the permit application, the IEPA will issue a draft permit that will be submitted for public comment. This public comment period should take at least 105 days. The permit review process can be expected to exceed nine months, including public comments and hearings.

Upon completion of the public comment period and barring any major issues, the IEPA will issue permission to construct the wells. Within 120 days of the completion of well construction and testing, a Well Completion Report must be prepared and submitted to the IEPA. The time required for the IEPA review of the Well Completion Report is undetermined. Upon approval of the Well Completion Report, the IEPA will issue a letter permitting injection. Upon initiation of injection, the groundwater, environmental monitoring and mechanical integrity testing programs must begin.

A recent experimental GS project in Illinois that was permitted under the Class I requirements required 14 months and approximately 6-7 full-time person equivalents to prepare the permit application. Based on this experimental permit, the total permit preparation for an IGCC facility may be 2 years or more and cost well in excess of $100,000.[20,21]

Transport Pipeline

The distance from the IGCC to the area of the geologic injection formation must be considered for costs associated with transportation pipelines. The Illinois Basin contains appropriate structural and/or stratigraphic traps, as well as, oil fields and coal seams. The pipeline route must minimize impacts to the public, landowners and the environment. Geographic Information System (GIS) software, databases and operators are required to model the most efficient pipeline routes.

CONCLUSIONS AND RECOMMENDATIONS

This Guidebook detailed the permitting requirements associated with a 600-700 MW IGCC facility fueled by Illinois coal. The guidebook detailed a total of 16 different major permits that are required for the construction and operation of such a facility. Depending on the permitting situation, acquisition of these permits can take between two to three years. The likely most costly permits include the Illinois Air Construction Permit (can reach up to $150,000), the Army Corps Water Related Construction Permit with Environmental Impact Statement (can total $100,000), and the carbon sequestration permit (can exceed $100,000). These estimates include both preparation costs and filing fees.

Interviews with practitioners have resulted in the following recommendations which should help expedite the environmental permitting process:

- Accurately predicting the IGCC plant equipment specifications and air emissions at the beginning of the project can save substantial air permitting time and cost. In-review changes in these parameters have been known to more than double the permit acquisition time of many projects.
- Regulations are continually being developed and modified. The regulations in effect at the time of project development should be discussed with the Illinois EPA.
- Review the historical BACT findings on other facilities with the Illinois EPA to ensure that you account for facilities which may have not yet been published in these data.
- The air dispersion modeling protocol is one of the most important documents at the beginning of a project to avoid unnecessary delays in the project schedule.
- An ambient air monitoring protocol, while not as critical as the modeling protocol, should be submitted to the Illinois EPA at the beginning of the PSD project to avoid any misinterpretations.
- Acquire a General Stormwater Permit for Construction Site Activities early in the permitting process to initiate construction on schedule.
- Meet with local zoning authorities early in the site selection process to identify requirements for conditional use, and to evaluate the history of conditional use permitting in the area of the proposed site.

REFERENCES

[1] The information in this section was obtained from the literature search as well as by phone interviews and e-mail contacts with Gary Stiegel (Director, Gasification Technology, NETL/DOE), Julianne Klara (NETL/DOE), Dr. Robert Smet (Illinois EPA), Harry Morehead (Manager IGCC, Business Development, Siemens Power Systems) and Kajal Mukerjee (Technical Director, Engineering, Worley Parsons).

[2] Robert Smet, June 19, 2006, "IGCC & Other Coal Gasification Projects In Illinois: An Air Pollution Control UpdatIllinois EPA"; Presentation.

[3] Julianne M. Klara & John G. Wimer, August 2007; "Cost and Performance Baseline for Fossil Energy Plants"; Vol. 1, DOE/NETL-2007/1281.

[4] Harry Morehead, August 3, 2007, Coal-Tech Presentation.

[5] Personal discussions with Harry Morehead (Siemens) on June 4, 2008.

[6] Application to The Minnesota Pollution Control Agency For A New Source Review Construction Authorization Permit Mesaba One And Mesaba Two, Excelsior Energy, June 16, 2006.

[7] EPRI CoalFleet User Design Basis for Coal-Based IGCC Plants (for Environmental specifications for a Greenfield IGCC plant).

[8] EPRI Gas Turbine Siting and Best Available Control Technology (BACT) Handbook. 2003 Update (Gas Turbine Permitting and Compliance Demonstration Handbook).

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[11] Project Summary for a Construction Permit Application from Robbins Community Power, LLC for a Power Plant in Robbins, Illinois, Illinois Environmental Protection Agency, February, 2008.

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[13] Review of Illinois' New Source Review Construction Permit Program, Illinois Environmental Protection Agency, August 2004.

[14] United States Environmental Protection Agency, October, 1990, "New Source Review Workshop Manual"; Draft.

[15] Project Summary for a Construction Permit Application from Christian County Generation, LLC for the Taylorville Energy Center Christian County, Illinois, Illinois Environmental Protection Agency, November, 2006.

[16] Discussions with Environmental Engineering Consultants in Illinois.

[17]Application to the Minnesota Pollution Control Agency For A National Pollution Discharge Elimination System Permit, Excelsior Energy, June 18, 2006.

[18] Siting New Coal-Fired Power Plants in Illinois - A Guide to Permits and Economic Incentives, Report of the Office of Coal Development, Revised September, 2005.

[19] Conversations with Illinois State Geological Survey.

[20] Information provided by GreenSmith Environmental, DesPlaines, Illinois.

[21] The Midwest Geological Sequestration Consortium website at http://sequestration.org/.

DISCLAIMER STATEMENT

This report was prepared by Steffen Mueller, University of Illinois at Chicago, with support, in part, by grants made possible by the Illinois Department of Commerce and Economic Opportunity through the Office of Coal Development and the Illinois Clean Coal Institute. Neither Steffen Mueller, University of Illinois at Chicago, nor any of its subcontractors, nor the Illinois Department of Commerce and Economic Opportunity, Office of Coal Development, the Illinois Clean Coal Institute, nor any person acting on behalf of either:

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Notice to Journalists and Publishers: If you borrow information from any part of this report, you must include a statement about the state of Illinois' support of the project.

APPENDIX A
PERMIT SUMMARY

A permit summary is listed below. The permit summary lists a) the general permit classifications (air, water discharge, process water usage, waste materials, carbon sequestration, b) the address of the permitting agencies, and c) the data required for the filing of the individual permit as well as the cost and time requirements.

Air Permits

Illinois Environmental Protection Agency Bureau of Air
1021 N Grand Ave. East
PO Box 19276
Springfield, IL 62694-9506
217-782-2113
www.epa.state.il.us/air/permits

Illinois EPA Construction Permit (PSD and NSR) – Required for construction and initial operation of facility.

Include in Filing:
Emission evaluations and calculation summary. BACT analysis. Ambient air monitoring evaluation. Permit application document/form preparation. Facility drawings, process flow diagrams, area maps.

Acquisition Time: 18 months
Minimum Estimated
Cost: $150,000

Acid Rain Notification – 40 (CFR) Part 72 – Generally submitted with the Construction Permit Application.

Include in Filing:
Form indicating status of the source as subject to acid rain program.

Acquisition Time: 18 months
Minimum Estimated
Cost: $150,000

Acid Rain Permit – Clean Air Act Title IV Acid Rain Program – Generally submitted with the Construction Permit Application.

Include in Filing:
Application data and forms indicating emissions and compliance with acid rain program.

Acquisition Time: 18 months
Minimum Estimated
Cost: $150,000

NO_x Budget Trading Permit - Operating permit pursuant to the regional NO_x Trading Program – Generally submitted with Construction Permit Application.

Include in Filing:
Selected facility representative as account officer. Emission units subject to the program and proposed allowable emissions.

Acquisition Time: 18 months
Minimum Estimated
Cost: $150,000

Illinois Clean Air Act Permit Program (CAAPP) Operating Permit – Permit required for ongoing operation of facility. Submitted after construction and initial operation.

Include in Filing:
Design, production and emissions information for each unit operation. Summary of regulatory requirements. Responsible official compliance certification. Initial compliance testing results. Continuous compliance monitoring system review.

Acquisition Time: 21 months
Minimum Estimated
Cost: $20,000 for application preparation
There will be an annual IEPA fee based on allowable annual emissions – currently $18/ton

Water-Related Construction Permits

Army Corps of Engineers
Cook County and Cook Collar Counties:
US Army Corps of Engineers
Chicago District Regulatory Branch:
111 N Canal St., 6th floor
Chicago, IL 60606-7206
312-846-5530
Fax: 312-252-4110

Rock Island Area:
US Army Corps of Engineers, Rock Island
ATTN: Regulatory Branch
Clock Tower Building
PO Box 2004
Rock Island, IL 61204-2004
309-794-5351
Fax: 309-794-5191

St. Louis Area:
Department of the Army Corps of Engineers
1222 Spruce St.
St. Louis, MO 63103-2833
314-331-8575
www.usace.army.mil/

Construction Permit – Construction activities in lakes, rivers, streams, wetland; 33 CFR 320 to 330.

Include in Filing:

Joint Permit Application with IDEM and IEPA. Needed for construction affecting rivers, streams, lakes and wetlands. All project data and construction specifications for activities affecting physical aspects of water resources. EIS is a comprehensive analysis of all environmental impacts from construction and operation for a proposed facility issuance of COE Construction Permit for a major action with significant environmental impact; 33 CFR 321 (rarely necessary)

Acquisition Time: 13 months without EIS
36 months with EIS

Minimum Estimated Cost: $20,000 without EIS
$100,000 with EIS

Illinois Department of Natural Resources
Division of Water Resources
One Natural Resources Way
Springfield, IL 62702-1270
217-782-3863
www.dnr.state.il.us

IDNR Construction Permit

Joint Permit Application with IDEM and Army Corps of Engineers. Required for dams, construction within a public body of water, and construction within floodways.

Include in Filing:

Design drawings for structures and shoreline protection. Evaluation of impacts on flood flows and sedimentation. The Illinois Wetland Policy Act of 1989 [20 ILCS 830] requires that all projects receiving State support shall meet the sate goal of no overall net loss of the state's existing wetland acres. Projects shall be submitted to the IDNR for a wetland impact assessment State agencies/ local governments which authorize, fund, or perform actions altering environmental conditions must consult IDNR and use their authority to avoid of minimize adverse impacts. 520 ILCS 10/11; 525 ILCS 30/17; 17 Ill. Admin. Code 1075

Acquisition Time: 8 months
Minimum Estimated Cost: $20,000

Historic Preservation Approval – Construction of industrial facilities require review of historical archaeological resources

Acquisition Time: 8 months
Minimum Estimated Cost: $20,000

Wetland Review – For projects receiving State support

Include in Filing:

Name and address of supporting agency. Project plans and design. Wetland delineation as required for Army Corps of Engineers permitting.

Acquisition Time: 4 months
Minimum Estimated
Cost: $10,000

Water Discharge Permits

Illinois Environmental Protection Agency Bureau of Water
Permit Section
1021 N Grand Ave. East
PO Box 19276
Springfield, IL 62694-9276
217-782-3362
217-782-3362
www.epa.state.il.us/water

State Permit for Construction of wastewater treatment equipment

Include in Filing:
Design information for wastewater treatment equipment. Expected characteristics of raw and treated water.

Acquisition Time: 4 months
Minimum Estimated
Cost: $10,000

National Pollutant Discharge Elimination System (NPDES) Permit – Clean Water Act Section 402; discharge of wastewater to surface water; required prior to operation, recommended to be obtained prior to construction.

Include in Filing:
Water balance diagram. Expected wastewater flows and characteristics. Water pollution control equipment and systems.

Acquisition Time: 11 months
Minimum Estimated
Cost: $15,000

NPDES Storm Water General Permit Construction Site – storm water runoff from construction areas; required before construction.

Include in Filing:
Storm Water Pollution Prevention Plan, including: site description, pollution and erosion control measures, maintenance procedures, contact information.

Acquisition Time: 2 months
Minimum Estimated
Cost: $10,000

NPDES Storm Water General Permit Operational Site – industrial storm water runoff; required prior to operation.

Include in Filing:

Storm Water Pollution Prevention Plan, including: site description, pollution and erosion control measures, storm water outfalls, facility contact information, maintenance procedures. Notice of Intent is submitted.

Acquisition Time: 2 months
Minimum Estimated
Cost: $10,000

Sewer Connection Permits – Construction and operation of connection to public sewer system; required prior to construction.

Include in Filing:
Design drawings of sewer connections. Description of wastewater and treatment equipment.

Acquisition Time: 3 months

Septic System Construction Permit – IEPA issues permits for septic systems larger than 1500 gallons per day, serving more than one building, and/or containing non-domestic wastewater

Include in Filing:
Design drawings of septic system

County Public Health Department

Check the local directory of the county where the facility will be built for contact information.

Include in Filing:
Design drawings of septic system

Process Water Usage Permits

Illinois Environmental Protection Agency
Division of Public Water Supply
1021 N Grand Ave. East
PO Box 19276
Springfield, IL 62694-9276
217-782-9470
www.epa.state.il.us/water

Water Supply Connection Permits – Construction and operation of a connection to public water supply system; 2 permits – one required prior to construction, another for operation of system. Permits typically issued to municipal water supplier, but obtained by the project developer

Include in Filing:
Design drawings of water connections. Description of water use plans.

Acquisition Time: 4 months
Minimum Estimated
Cost: $15,000

Illinois Department of Public Health
525 W. Jefferson
Springfield, IL 62761
217-782-5830

Well Installation Permit – Installation of new groundwater wells used for non-public drinking water system; required before construction.

Include in Filing:
Design drawings for wells. Plans for disinfection and sampling.

Acquisition Time: 4 months
Minimum Estimated Cost: $10,000

County Public Health Department
Check the local directory of the county where the facility will be built for contact information.

Well Water Withdrawal Permit – installation of new groundwater wells used for non-public drinking water system; required prior to construction

Include in Filing:
Design drawings for wells. Plans for disinfection and sampling.

Acquisition Time: 4 months
Cost: Included in IDPH permit above

Waste Materials

Illinois Environmental Protection Agency
1021 N Grand Ave. East
PO Box 19276
Spring field, IL 62694-9276
217-524-3300
www.epa.state.il.us/land

Assignment of RCRA Small Quantity Hazardous Waste Generator Identification Number

RCRA Small Quantity Hazardous Waste Generator Identification Number would be assigned for the collection and shipment of hazardous waste, such as mercury captured on activated carbon. Required if hazardous waste will exceed the 100 kg/month threshold; 40 CFR Part 261

Acquisition Time: 1 month
Cost: Negligible

Carbon Sequestration

Illinois Environmental Protection Agency
1021 N Grand Ave. East

PO Box 19276
Spring field, IL 62694-9276
217-524-3300
www.epa.state.il.us/land

Geological sequestration injection well permit

Include in Filing:

Descriptions of the area geology. Well construction materials. Proposed depths of the injection and monitoring wells. Groundwater monitoring program and a mechanical integrity testing program. Demonstration that no hazardous constituents will be included in the carbon dioxide stream at concentrations greater than their respective MCLs. Calculation of the capacity of the formation that will receive the injection.

Acquisition Time: 38 months
Cost: Unknown. Permitting anticipated to exceed $100,000