TECHNICAL REPORT

Technical and User Review of the Nodal Analysis Tool

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EXECUTIVE SUMMARY

This document presents the results of a technical and user review of the Nodal Analysis Tool (NAT), a web-based e-learning model of the oil and natural gas industry. The primary purpose of this review has been to obtain objective input on the current usefulness, functionality and maintainability of the application, as well as obtain specific recommendations for improvement. A cross-section of users representing academia, industry, technology vendors, non-for-profit environmental organizations, government and environmental engineering consultants was surveyed. In addition, a technical review of the application architecture and programming was completed.

Overall, the reviewers felt the NAT was a useful tool. While there were some areas of general agreement, there were also some areas of conflicting opinion. Clearly, it is not possible to make the NAT satisfy the needs and expectations of all users. Nonetheless, sufficient input was provided to facilitate the development of key recommendations for future enhancement and refinement of the application.

The key areas for improvement comprised the following:

- Refinement of the architectural design of the application to facilitate improved maintainability and on-going enhancement of the applications.
- A variety of improvements to the navigational functionality of the application.
- Enhancement of the database content.

It is recommended that these improvements be implemented as part of the next phase of development.

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1 INTRODUCTION

This report presents the results of a technical and user review of a web-based interactive flowsheet-style model of the oil and natural gas industry. This application is referred to throughout the remainder of this report as the Nodal Analysis Tool (NAT). The primary purpose of the review has been to develop recommendations for further refinement and enhancement of the application. The review comprised a limited survey of potential industry, government, technology vendor, researcher and institutional end users, and a critical review of the current program architecture. Input and comments were sought in two general areas: (1) NAT content and (2) Ease of use. The reviewers were requested, via a list of questions, to focus on the usefulness of the NAT as a training tool for users from industry, research and government groups. The overall aim was to obtain guidance for development of the NAT in a manner that best meets the needs of the key user groups."

The current version of the NAT, available on the internet at http://osio.clearstone.ca, was used as the basis for this review. The NAT, as partially updated in March 2010 under contract with PTAC, was developed as an NRCan version from the original USEPA Global Methane Initiative (formerly known as the Methane to Markets [MTM] Partnership) platform.

A copy of the instructions and questions provided to the reviewers is presented in Append 1. The information requested was very comprehensive and required the trial users to thoroughly and critically search the NAT, taking into consideration the perspective of the potential audience, from technical novices to industry experts. Some of the experts contacted (ten in all) were not able to respond due to personal work and schedule commitments. Those that provided input are listed in Appendix 2. The feedback from the six reviewers was very comprehensive and as such it was not necessary to solicit further input via another round of requests (copies of the responses provided by each reviewer are presented in Appendix 3).

An overview of the reviewer responses is provided in Section 2.

Section 3 delineates the key recommendations based on the reviewer input.

Section 4 summaries the technical review of the NAT architecture and code provided by Dr. Dan Field. A complete copy of his report is presented in APPENDIX 4.

The final recommendations of this study and a work plan for prioritization of these recommendations is presented in Section 5.

2 EXPERT FEEDBACK

The majority of the reviewers addressed all of the questions on the list, with some providing comprehensive detail on technical content, NAT structure and mechanics of use. Most recommended areas for additional technical content and advised they would be willing to participate in development of such content. The reviewers were unanimous in defining a need for substantially more information on the subject of the environment, particularly industry impacts, technologies and controls, as well as attendant regulations.

Significant problems were identified in the NAT ease of use related to accessing or searching for information. Comments were also received that pointed to the problem of achieving consistency across the industry sectors (Oil, Natural Gas and Oil Sands) in terms of type and level of information.

The sections below present the consolidated views of the expert reviewers. Differences of opinion are noted such that decisions will ultimately be required to resolve the best approaches when the NAT is upgraded in future work.

2.1 Current Content of the NAT

2.1.1 NAT Objective and User Focus

All of the reviewers agreed with the objective of the NAT as being primarily a learning and education tool for those being introduced to the oil and gas industries. However, one key comment was that this objective was not clear to the first-time user, and it should be identified as a first display when the NAT is accessed. This objective would clearly state the anticipated audience and identify the purpose of the learning program. Additional comments supported the idea of a “Home” page as a starter page.

The reviewers also were consistent in concurring with the present general format based on flow diagrams, icons and direct links to more detailed flow schemes and the sub subjects, e.g. Industry Description. Opinions varied as to the amount of content that should be included in various areas and the extent and depth of knowledge that could be added. In other words, there was some variation in opinion on the ultimate level of user background and user expertise that should be targeted. These opinions are further expanded in the detailed sections below.

2.1.2 Flow Diagrams and Graphics

All of the reviewers stated that the flow diagrams themselves were good and very useful. The main critique was that there was not consistency across the industry sectors and across the various nodal levels. For example, one sector (Oil) contains some flow sheets at the P&ID level, and it is recommended to eliminate these. Two reviewers also suggested strongly that some technologies, the main example being flaring, were treated too generally and that flaring should be included in only those processing areas where flaring is practiced, but also with appropriate detail of description.

The majority of the reviewers advised that the NAT requires substantially more graphics and photos, particularly in the Industry Descriptions. This has always been the objective of the NAT developers, subject to the availability of these materials. In particular, representative photos of many of the processes presented as flow diagrams have not been available due to confidentiality restrictions by industry operators. This challenge has to be addressed going forward.

Specific comments were made regarding the need to expand the span of the conventional oil and gas sectors, including land use issues, exploration, drilling, completions, pipelining, water supply, waste water handling and sour gas handling and processing. Addition of the refinery processes with detailed flow schemes and related sub subjects and levels was also proposed. The reviewers were again unanimous in the need to address all areas of environment management as required and practiced in each of the industry sectors (land use, energy use, greenhouse gases, air emissions, water management, waste management, and land reclamation). This topic is discussed further in Section 3 below.

2.1.3 Industry Descriptions

The comments received focused mainly on suggested additions to the technical subject areas (as mentioned above, e.g. exploration, wells, environmental) and on inconsistencies across the sectors, rather than the relevancy or accuracy of the current content in the NAT. This is quite understandable given the volume of information currently in the NAT and the limited time given to the reviewers. Inconsistencies addressed included comments on questionable contents such as detailed PowerPoint presentations, and deficiencies in other areas, e.g. some nodes such as gas wells, flaring & venting need to be more industry specific. The industry consultants recommended that some areas need quality upgrades. It is proposed that other themes should be added as well, such as comparative resource utilization amongst the various options for oil production, perhaps even including biofuels. As mentioned elsewhere, the recommendation to add discussion on industry impacts in the areas of water, waste and land issues is paramount.

Some reviewers commented that it was cumbersome to access the descriptions, and the formatting is inconsistent. More review is presented on this issue in Section 2.2 “NAT Architecture and Ease of Use” below. The need to link to key outside sources was a common theme and also perhaps the use of more active graphics such as video clips. These topics are also discussed in Section 2.2.

2.1.4 Control Technologies

One reviewer considered this information as the most useful component of the NAT. Some reviewers questioned, again, the inconsistency of information across the industry sectors and subsectors, where it was not clear why some technologies were presented and others weren’t. One reviewer suggested that in any given industry sector, technology options could be presented in detail with a process selection flow chart, with the NAT serving as good practical tool for junior engineers. Another expert went even further, with the suggestion that ultimately an interactive training system could be added, for example in the area of waste water treating.

Some experts cautioned against allowing vendor input to the NAT, as there is too much competition amongst vendors on technologies and equipment for processing and for

environmental controls. It is recommended that vendor featured equipment could be referenced in cases where a typical piece of equipment is used by the industry, for example flare tips.

2.1.5 Environmental Issues R&D

The reviewers generally agreed that all environmental areas need to be addressed if the NAT is to be adequately comprehensive as a learning tool given today's emphasis on the environment. However, after that, this topic elicited the most diversity in the feedback. One expert suggested that only high-level needs for environmental management should be included, whereas at least one reviewer proposed that comprehensive impact analysis of industry's effect on the environment should be addressed for all operating sectors. Finally, it was suggested by another that control options should be addressed in detail for all areas of regulation. Providing links to the web sites of regulators and their pertinent current regulations was also recommended. Overall, this area will require reevaluation in view of these recommendations. Firstly, the original purpose of this topic was to address required R&D so that prospective researchers and research institutions would have a reading from industry on the priority areas for resolving their environmental management challenges. Secondly, the original mandate from NRCan was to address Air Issues which is why this heading in the NAT was titled "Air Issues R&D". The reviewer recommendations on the added content means this component of the NAT would be retitled to "Environment Issues R&D". Finally, this component of the NAT should retain its focus on research needs, as the discussions on environmental impacts and current environmental practices would be included in the Industry Descriptions.

2.1.6 Projects

One expert recommended against project tracking since updates would be costly and there are many other sources published regularly. Other reviewers ignored this item or stated that they were not able to understand the utility of the topic. It was also stated that the details and formats were inconsistent across the NAT.

It is noted that this node is relatively unpopulated in the Oil and Natural Gas sectors, and was not utilized in the Oil Sands component, where it was replaced with the "Air Issues R&D" topic. The general impression from the feedback is that this node does not serve a useful purpose. This will have to be considered in going forward with NAT development.

2.1.7 Glossary

The feedback from those that commented on the current Glossary was mixed. Two reviewers found it useful and important and one even suggested enhancing it. Others found it deficient in both means of access (where placed in the architecture) and in content. One reviewer recommended that an external glossary (via linking) would be best since there are many sources of industry definitions.

It is noted that the bulk of the current Glossary was built for the original US EPA version. Oil Sands terms were added during the 2010 work. The architecture allows accessing the glossary separately or selectively when in lower levels in each industry sector, but one expert suggested that direct links from the text terms be incorporated to allow the reader to quickly go back and

forth as each term of interest is encountered while reading. The mechanics options for handling the Glossary require attention and are discussed further in Section 4. Overall, the majority opinion is that a Glossary is an imperative feature of such a learning tool. Based on the feedback, a critical look at the content and the means of accessing the definitions should be undertaken.

2.1.8 Depth of Technical Information

It might be expected that opinions would vary on this subject, and that was the case but only to a moderate degree. The reviewers generally approved the level of technical detail currently in the NAT – independent of their many suggestions for what should be added or revised. Two reviewers suggested that a more advanced level of technical expertise could be incorporated, but one conceded this would be a future exercise depending on the evolution of the NAT's use. Another expert commented that for clients at the "management level" the reader may not wish to enter immediately, if at all, into the current technical levels, and there should be an overview level of material.

2.1.9 Other Additions to Technical Content

One reviewer strongly emphasized the need to define the purpose of the NAT in terms of target audience and objectives for learning. Otherwise it would be difficult to tailor the contents with a consistent approach.

Most of the reviewers gave a strong recommendation that the subject matter must include additions to the Environmental content, e.g. energy, water, land, GHG's, air emissions, waste management, safety, reclamation, noise, life cycle analyses (LCA), resource recovery, human impacts & regulations. One reviewer proposed that the presentations should start with a detailed discussion of current impacts the industry is having on the environment. Others emphasized the need to include related controls requirements, control measures and cost & economic impacts. An emphasis on the needed solutions to these impacts (procedures, technology, R&D) is required.

One user suggested that the refining sector would be enhanced with added descriptions of the individual refining processes, plus there should be more description of refined products handling.

One expert's opinion was that the key components are the flow diagrams, the Control Technologies, Environmental R&D requirements and environmental regulations. Generally, more photos, schematics and simplified flow diagrams are desired. The addition of industry case studies should also be considered. As mentioned above, the support flow diagrams in some cases need simplification for the target user levels as well as giving a consistent approach across the NAT. Again, it was opened for discussion as to whether, and when in the development progress, a more detailed industry expert level would be added.

Regarding industry case studies, suggested above, it is noted that certain presentations, including PowerPoint slides, are currently in the NAT which do give a sampling of case studies. The consideration is that the NAT could balloon if such studies are added ad hoc. This topic invites a critical review during the next phase of work.

One reviewer raised several suggestions for potentially including themes that would go beyond strictly technical material and enter into the realm of social and/or political matters. These themes include areas of current "debate" among industry, government and public (including NGO's) stakeholders. The expert felt that this would be an appropriate forum to present balanced views (i.e. not industry lobbying) to the users. Examples proposed were: (a) Explanation of the "wells to wheels" debate - clarification is direly needed on the framework options quoted by the various players to explain the comparative emissions from oil and oil sands production, i.e. from production site only, from production through refinery tankage, or from production to consumption (wells to wheels); (b) The economic and social benefits and/or penalties of upgrading bitumen in Canada vs. shipping raw bitumen for export; (c) The externality issues related to aggressive exploitation of resources (primarily oil sands) that result in a social legacy, e.g. GHG emissions, disrupted land, tailings deposits; (d) The social implications of (beneficial) royalty and tax structures to induce development of resources. The purpose of delving into these topics is to objectively present the views on all sides of the debates such that readers would be better educated on the issues and be able to make their own conclusions from non-biased discussions. It would be up to the nodal project sponsors to determine the role of such material and insert it in the appropriate place in the NAT (Industry Description?).

2.2 NAT Architecture and Ease of Use

A large number of questions on this subject were directed at the reviewers as it was felt necessary at this time to take a critical look at the software platform. If the current ACCESS data base architecture is too cumbersome for expansion of the NAT, user interface, and/or ease of navigation this would likely be the appropriate time in the NAT development to convert to a new system. The sample feedback as obtained from the select reviewers is discussed below.

2.2.1 Navigation Amongst Levels (Finding Information)

Opinions received on this topic were quite diverse. Two reviewers found the navigation generally ok, with the flow diagrams and side bars working fine. The remaining reviewers commented that the navigation was clumsy beyond the flow diagrams, as it was cumbersome to "dig down" for sought information, hence, more capability in the ease to drill down to detail from the flow diagrams is desired.

One expert suggested eliminating the side bars. The method of linking to auxiliary files and opening them, particularly the WORD files, was undesirable. Cross linking capability is clumsy and a search option is not available. More cross linking across the NAT, e.g. back and forth from the Glossary is recommended. Reversing some buttons did not produce the desired page. It was also suggested that the buttons should be more descriptive and the arrows on the flow diagrams could even be active. Finally, it is agreed that the inconsistency of information at the particular levels across the NAT add confusion in navigation.

The reasons for the diversity of opinions are not entirely clear, but it is obvious that different users have varied opinions on how information search engines should perform. Another consideration may be how much the NAT was explored by each individual and how much "digging down" and cross referencing was attempted.

2.2.2 Information Levels and Detailed Content

There was general agreement that the number of "levels" used and the information contained in each (in terms of targeted technical detail) is appropriate for this learning tool. The main area of critical feedback focused on the Inconsistency of information in the levels across industry sectors, for example, one reviewer stated that the Oil Sands component contains plenty of information whereas some of the oil and gas sub sectors require much more input. Another expert stated that the levels are ok but respective details across the NAT need much more work on consistency and some areas require "much more work".

One reviewed commented that the flow charts in levels 1 to 3 for all of the sectors levels should be more basic. Another expert recommends a review of the staging of the technical detail from the higher to the lower levels, and it is implied this is due to inconsistency. .

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Most reviewers felt that the level of technical detail was appropriate for the education of junior staff. Over and above this it was questioned as to whether there should be a separate "overview" level for management and non-technical staff, and further, a more detailed level for industry experts.

All reviewers recommend the use of quick links to access auxiliary information and to search for specific topics. More graphics and photos should be available at the lower levels. Videos would be useful as would be more exterior links to training and workshops

Most reviewers cautioned against adding other industries such as Chemicals at this time. The current focus should be on the upgrading of the NAT according to this review.

2.2.3 Links to External Sources

There should also be links to outside sources to access other training, workshops, reports and BMP's, e.g. PTAC and CAPP. Also of high importance would be links to the web sites of the regulators, and a quick link list of relevant regulations.

Another suggestion is to add a feedback site to allow users to comment on the NAT content and its use.

2.2.4 NAT Platform

There was no strong recommendation to change the NAT platform at this time if the recommended upgrades could be made with the current architecture. This caution centers on the concern that a large amount of effort could be required. It is also recommended to assure the NAT does not become too large and unwieldy, but no examples are provided as to what would be considered too large.

3 RECOMMENDATIONS FOR NAT IMPROVEMENT

This section intends to consolidate the input from the experts review process to provide specific recommendations for the next phase of the NAT development. The information provided by the six reviewers is deemed sufficient as a critical review of the NAT, along with some input from the authors who have familiarity with the NAT. In instances where the experts had differing opinions, these will be addressed, but still with the intention of making final recommendations. This means that in the end, some suggestions will likely be set aside.

3.1 Content of the NAT

3.1.1 NAT Objective

It is evident from some feedback that the objective of the NAT is not stated clearly as part of an introduction to users. Additional comments support the idea of a "Home" page as a starter page. This would lead the developers to consider the contents of such a page and the following are recommendations:

(a) welcome the users and indicate who would benefit from exploring the learning tool
(b) present the expressed purpose of the NAT.
(c) advise the user of the general NAT architecture, i.e. topics and levels of information
(d) provide the user with instructions on how to use the various tools available for learning and searching (the latter one would depend on the scope of the search capability).
(e) provide a link to the starter page, i.e. on the general industry sectors flow diagram.

3.1.2 Flow Diagrams

The flow diagrams with descriptive icons that also provide triggers to subject material are the backbone to the NAT. All reviewers responded to this feature positively and It is recommended that the current structure and method of presentation be retained, which would also apply to any new diagrams (e.g. refining) and any revisions inside the sectors (e.g. flaring on oil and gas operations).

3.1.3 Industry Description

Several significant complaints were registered regarding this NAT content: firstly, there is considered to be inconsistency in the volume of material across industries and secondly, there are contradictions as to what amount and depth of discussion is presented as one migrates through the four levels. Further, more photographs and graphics are required to allow unfamiliar users to obtain a good picture of the hardware employed in the various steps of exploration, drilling, completions, mining, processing, etc.

Addressing this issue would be important to improve the overall presentation of information and facts. A substantial work effort by a team of experts would have to be utilized to conduct this remedial effort. Most of the reviewers advised they would be willing to participate in these activities and, depending on Phase 2 funding, this work plan is highly recommended.

The restrictions related to obtaining industry photographs are well known and this road block has to be broken. It is recommended that industry operators and perhaps vendors of key equipment be contacted and agreements reached on what can be photographed and whether there are limits on the use of the material.

3.1.4 Control Technologies

The feedback comments in this section are a repeat of those listed directly above in Section 3.1.3 for the Industry Descriptions. Again, there was questioning as to the observed variations in detail across the NAT, including questioning as to why certain technologies were not mentioned. These comments warrant a review similar to that recommended above for Industry Descriptions

3.1.5 Air Issues R&D

Limited feedback was received on this specific topic in the NAT. The recommendations focused on the importance of including all environmental areas (land, air, water, waste, etc.) starting with current impacts and issues and proceeding through remedial requirements, available controls and governing regulations. Populating the NAT with this extent of topics and detail requires input by select specialists across all of the industry sectors and across technologies. It is recommended that an Environmental task team including the current reviewers be assembled to roadmap the proposed contents in detail and devise a work plan to assemble the input and incorporate same into the NAT.

3.1.6 Projects

This node caused the most confusion and its intent and need were questioned. It is recommended that this category be eliminated from the NAT and replaced with the above Environmental subject.

It was suggested that case studies be used as practical learning material. It is noted that some examples already exist in the oil and natural gas sections and others can be added in the NAT as reasonable. Such studies would normally fit in the Control Technologies area and it is recommended to place them there.

3.1.7 Glossary

Since opinions varied widely on the need, placement and access to the definitions, a careful evaluation is required. The original US EPA NAT contains a very large compendium of definitions, and this was expanded in 2010 to include Oil Sands. The majority of the reviewers advised that the Glossary is important therefore the mechanics related to the access issue need to be addressed during the review of the NAT architecture.

3.1.8 Other Additions

As detailed in Section 2.1.9 above, the reviewers proposed a significant quantity of information that should or could be added to enhance the educational utility of the NAT. Overall, it is recommended that the expansion of the Environmental component is mandatory and in the

succeeding phases of work, industry experts would need to be contracted to develop this material. Regarding the inclusion of case studies, these would need to be carefully scrutinized for relevancy and added value, again by the experts, since these can readily increase the bulk of the NAT. Finally, the suggestion to add the topic of social/political issues would be up to the sponsors of this NAT project.

3.2 NAT Architecture and Ease of Use

Generally, the reviewers found the NAT navigation to be straight forward as long as only the flow sheets and select information nodes were accessed. This would say that this part of the platform is generally acceptable as a "one way" learning tool. In other words, if a user is studying a given industry sector while following the flow sheets the "down linking" process is adequate. The major deficiencies can be listed as follows:

a) The ability to readily find material by subject or by cross searching amongst nodes is severely limited. This is attributable to the deficiency in "hot buttons" and the absence of search capability which hinder this process. It is likely the current database platform does not render such mechanics as readily workable.
b) The use of the side-bar was found to be questionable by some users, with comments that it only confused the search process. Others found the side-bar to be ok. It is unknown as to extent that the side bar feature was attempted during the limited time for review. But this feedback should be considered as an item to be addressed, since any expressed user confusion or cumbersome operation will result in frustration and a tendency to ignore the NAT.
c) It is reported that the ability to use "back arrows" is not workable in parts of the architecture. These areas need to be identified and rectified.
d) Some material, e.g. in the Industry Descriptions, is included where the subject area is opened, whereas other material requires triggering a link. Further, the formatting of the linked material varies, including WORD, pdf, etc. Standardization of the linking is required along with substantial "clean up" of the formatting. All documents requiring linking due to their volume are to be converted to pdf format for security purposes.

4 ARCHITECTURAL IMPLEMENTATION AND REVIEW

4.1 Review Approach

Dr. Dan Field, an information technologies specialist, provided an evaluation of the current software platform used of the NAT. Specifically, Dr. Field was requested "to conduct a study of the architecture, implementation, functionality and usability of the NAT as implemented in a systematically designed and hierarchic fashion". In assessing the functionality and usability of the platform, Dr. Field considered his own trial use and the feedback reported by the expert reviewers. He then assessed the construction of the architecture and its ability to provide the desired functionality and usability.

4.2 Overall Assessment

Dr. Field identified significant deficiencies in the manner in which the current data base architecture is employed, leading to limited NAT flexibility and limitations in the ability to readily make additions to NAT content. Dr. Field provided several recommendations for programming adjustments and additions necessary to rectify the deficiencies. Overall, substantial rework is required to revise the required portions of the program code.

4.2.1 Functionality

Since users normally expect search capability, this feature should be built in and can be readily accomplished within the current program. The use of "flash" architecture for the flow diagrams inhibits printing capability and an alternate graphics tool should be employed to enhance the management of the flow diagrams and their images, including the ability to print them. It is recommended to utilize "*sitemap"* files to enhance browser access.

4.2.2 Usability and User Interface

1. Ease of forward and backward navigation amongst the side bar and the flow diagrams was a common complaint of the reviewers and this was also recognized by Dr. Field. He proposed that features such as additional buttons be implemented to rectify this problem.
2. The formatting of the text files (converting to HTML and pdf) is required to enhance navigation and provide standardization.
3. Consideration should be given to the requirements for "internationalization" and "unsighted person" access.
4. It is recommended that "error handler" pages be added to guard against browser user errors.

4.2.3 Maintainability and Extendability

The current file linkage structure in the program is too complex, which makes it very difficult to maintain, augment and verify the program. A couple of remedial options are suggested, i.e. either building a sub program to handle the current data base structure or using a different programmed tool for this particular operation.

4.2.4 Code Duplication

Mr. Field reports that the original program was built without the use of templates or other duplication techniques, hence making modifications in many cases necessitates handling large numbers of files individually. He advises this issue is resolvable but he does not comment on the extent of work that would be required.

4.2.5 Web Site Security

The web site is currently vulnerable to hacker activity and it is imperative that this shortcoming be addressed.

4.2.6 Summary Recommendations

It is concluded that the current database architecture could be retained, but a number of new programming features are needed to improve the considerations of functionality and usability and, moreover, the ability to make additions and maintain the NAT. This suggests that user-interface modifications are required along with a rework of information handling routines.

5 PRIORITIZATION OF NAT ENHANCEMENTS AND UPGRADES

Table 1 provides a work plan for attending to the next phases of NAT development, as would be carried out based on the recommendations in this report. It is proposed that prioritization would be effected by handling the enhancements and upgrades in the two stages as shown. The purpose of Stage 1 is to limit the immediate work to that required to improve the NAT toward a "proof of concept" version for the purpose of soliciting support for its ongoing development. The Stage 2 activities would incorporate the listed recommendations and give a final NAT for public use.

Table 1: Summary of reviewer recommendations.

Recommendation	Priority Assessment		
	Stage 1	**Stage 2**	**Hold**
User Interface and Ease of Use			
1. Add Home page with Introduction, Objective & links	**O**		
2. Provide increased cross linking capability, e.g. access to glossary from text.		**O**	
3. Provide search capability			**O**
4. Enhance use of graphics, e.g. active arrows.			**O**
5. Evaluate the need for and use of the side bar		**O**	
Technical Content			
A. Flow Diagrams			
1. Delete the detailed block, P&ID & PFD diagrams and replace with simplified diagrams.	**O**		
2. Make select revisions to existing flow diagrams (flow scheme, icons and links), e.g. flaring, per expert recommendations to better represent industry configurations.	**O**		
3. Add recommended new flow diagrams with icons and links, e.g. refinery		**O**	
B. Industry Description			
1. Add industry sub-sectors to Oil and Gas sectors, i.e. reserves, land use, exploration, drilling, completions, pipelining, water supply, waste water handling, sour gas handling and processing.		**O**	
2. Review descriptions across the NAT for consistency in content in all of the levels	**O**	**O**	
3. Add and/or revise descriptive levels for wider audience knowledge levels		**O**	
4. Add detailed descriptions of all environmental impacts – land use, energy use, greenhouse gases, air emissions, water use, waste generation, and land reclamation.		**O**	

Table 1: Summary of reviewer recommendations.			
Recommendation	**Priority Assessment**		
	Stage 1	**Stage 2**	**Hold**
5. Add resource utilization comparisons, e.g. wells to wheels, life cycle analyses, energy ROI		**O**	
6. Expand descriptions of refining to the individual processes.		**O**	
7. Add more photographs and other graphics to the detailed descriptions	**O**	**O**	
8. Review formatting of the content and convert to consistent presentation, i.e. imbedded text vs links, conversion to pdf, etc.	**O**	**O**	
9. Add discussions of social issues, including (a) Externality issues vs domestic benefits of continuing energy developments for the purpose of exporting to others (b) exporting raw resources (e.g. bitumen) vs adding value (e.g. upgrading) domestically.			**O**
10. Critically review options for linking to external sources, e.g. for refinery presentation vs including such information in the NAT.		**O**	
C. Control Technologies			
1. Add detailed descriptions in each industry sector for control technologies to cover all environmental impact areas – land use, energy use, greenhouse gases, air emissions, water use, waste generation, and land reclamation.		**O**	
2. Review descriptions across the NAT for consistency in content in all of the levels.	**O**	**O**	
3. Add and/or revise descriptive levels for wider audience knowledge levels (management to journeyman technical).		**O**	
4. Review formatting of the content and convert to a consistent presentation, i.e. imbedded text vs links, conversion to pdf, etc.	**O**	**O**	
5. Develop and include process selection flow charts			**O**
6. Add interactive training tools			**O**
7. Add level for industry experts			**O**
8. Critically review options for linking to external sources, e.g. CAPP, PTAC (BMP's, etc.) vs. including such information in the NAT.		**O**	
9. Add industry case studies on environmental management		**O**	
10. Evaluate the efficacy of including economic analyses in selecting environmental controls		**O**	
D. Environmental Issues R&D			
1. Increase content for R&D needs from air emissions issues only to all environmental impact areas - land use, energy use, greenhouse gases, air emissions, water use, waste generation, and land reclamation.		**O**	
2. Add links to regulatory bodies and relevant regulations that apply		**O**	

Table 1: Summary of reviewer recommendations.			
Recommendation	**Priority Assessment**		
	Stage 1	**Stage 2**	**Hold**
to the industry sectors and the environment impact areas.			
3. Review options for linking to external sources vs. including such information in the NAT.		**O**	
4. Change NAT link heading from Air Issues R&D to Environmental Issues R&D.	**O**		
E. Projects			
1. Delete this component from the NAT	**O**		
2. Move any relevant case studies to the Control Technologies or Environmental R&D components	**O**		
F. Glossary			
1. Re-evaluate its placement in the architecture for enhancement of user access		**O**	
2. Provide access to the glossary definitions via internal links when these terms show up in the text discussions		**O**	
3. Review all glossary terms for consistency in descriptions across the industry sectors.		**O**	
NAT Software			
1. Determine the best software platform package (with costs) to meet the user identified enhancements	**O**		
2. Convert the NAT to the new platform, with recommended NAT upgrades		**O**	

6 APPENDIX 1- QUESTIONS FOR THE REVIEWERS

Nodal Analysis Model - Questions for Reviewers

A. Model Objective

1. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?
2. Does the system contain the information you want (if not, what is missing)?
3. Can you find the information you want readily?
4. Does the model go into sufficient detail in the areas of interest?
5. Would you be willing to contribute information to the model?
6. What parts of the model do you find most useful and what parts do you find least useful, and why?
7. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?
8. Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?
9. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?
10. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

C. Model Structure

The current model intends to include information against these main Categories:

Flow Diagram
Industry Description

Control Technologies
Projects
Air Issues R&D
Glossary of Terms

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a "cold eyes" perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

E. Model Detailed Content

1. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.

   Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

2. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

7 APPENDIX 2 – LIST OF REVIEWERS

Table 2: List of reviewers for the Nodal Analysis Tool (NAT).			
Name	**Organization**	**Telephone**	**E-mail**
Jim Spangelo, P.Eng.	ERCB Field Surveillance & Operations Branch	Phone: (403) 297-3566	jim.spangelo@ercb.ca
Larry Richards	Hy-Bon Engineering Ltd.		lrichards@hy-bon.com
Ed Brost	JE & M Consulting Ltd.	(519) 312-8650	ed.brost@gmail.com
Bruce Peachy	New Paradigm Engineering Ltd.	(780) 448-9195	newparadigm@shaw.ca
Nathan Lemphers.	Pembina Institute 219 19th St. NW Calgary	(403).269-3344 x124	
Dennis Paradine	BC Government Climate Change group		Dennis.Paradine@gov.bc.ca

8 APPENDIX 3 – COMPENDIUM OF THE REVIEWER RESPONSES

8.1 Reviewer No. 1

A. Model Objective

1. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?

a. It was straightforward to understand the flow diagrams as they provided a contextualized schematic of the industry operations. However, it was difficult as a user interested in the environmental management of the industry to get a contextualized understanding based on the current model architecture.
b. Senior level staff typically do not have a lot of time to review material. If this tool is intended for busy decision-makers then there will need to be more contextual, higherlevel information. There is currently a significant amount of information at a fairly high level of detail. This amount of detail may be helpful for junior staff but may not be as relevant for senior staff.

2. Does the system contain the information you want (if not, what is missing)?

a. The system doesn't contain broader information on the impacts (social, environmental, economic) of the oil and gas industry. Perhaps this isn't the intention of the tool, but just as it is important to explain the intention of the model, it will also be important to describe to users what this model is not intending to cover.
b. The current flow diagram architecture is excellent for explaining industry processes but it is difficult to get a sense of not only the sections that are not graphically illustrated (Control Technologies, Industry Description, Project Opportunities) and also how the industry affects the environment.

3. Can you find the information you want readily?

a. Information presented in the flow diagrams can be found readily but the information contained within each node (Control Technologies, Industry Description, Project Opportunities) was more difficult to obtain. Not having to download additional documents would help to make this information more available to users.

4. Does the model go into sufficient detail in the areas of interest?

a. The model goes into sufficient details for the some of the areas; however, there is no information presented on some of Pembina's major areas of interest: reclamation of oil sands mines, end pit lakes, and cumulative effects. The model presents a detailed introduction to the production process of a typical operation but does not provide the user with any information about the effect of the industry as a whole on the

environment. For example, there is no mention of the effect that habitat fragmentation from in-situ operations have on caribou.

5. Would you be willing to contribute information to the model?

a. Yes, Pembina would be willing to share information and stakeholder concerns on the environmental impacts associated with oil sands development.

6. What parts of the model do you find most useful and what parts do you find least useful, and why?

a. Most useful
i. The model was very useful for sharing the flow diagrams and for familiarizing the user with how an operation relates to the larger system.
b. Least useful
i. Having to download MS Word documents to read more. Perhaps this step will be removed in future iterations but it made the site navigation disruptive and provided a disincentive to learn more.
ii. Not being able to follow the arrows on flow diagrams when they go off screen. Ideally a user could click on the arrow to see the next stage without having to click 'back' or use the sidebar list of flow diagrams.

7. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?

a. The graphics could be enhanced through the use of additional photographs in the flow diagrams.
b. The arrows used in flow diagrams are very low resolution and make the model seem dated. Using more dynamic and modern arrows and icons in the flow diagram would convey that the model is 'state of the art'.
c. The photographs in the Industry Description section were helpful. Even more pictures could be added to quickly visualize what is being conveyed in the text.

8. Does the program serve as a more efficient means than traditional search engines for endusers to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?

a. Absolutely, this is more efficient that using traditional search engines, if I wanted to learn about the process of oil and gas development. For information areas that are only briefly mentioned in the tool (environmental effects), a search engine would provide access to more comprehensive information sources.
b. It may become problematic if many technology vendors and researchers start disseminating their information as there would have to be QA/QC provided on information listed in the tool, or at least a caveat explaining this is information not verified by the model owner.

9. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?

a. This could become an interactive tool, but the architecture of the current website would have to change to facilitate this interaction. The four buckets (flow diagrams control tech., industry description and project opportunities) would not accommodate that level of interaction given their current format.
b. If there was to be more interactivity, it would need to be more clear how this website would add value to the existing online fora for sharing information on the oil and gas industry.
c. Expanding into these additional areas may make the website too unwieldy with respect to the amount of information hosted on the website. It is difficult to effectively operate one website just for oil sands on one of these issues.

10. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions.
Please provide any suggestions you may have for modifications or improvements.

a. It is difficult to comment on this objective if there is not more information provided on the learning goals of the tool. If your goal is to know how the oil and gas industry gets its product to market, then this tool would be highly effective. If your goal is to learn about the environmental, economic or social impacts created by the oil and gas industry, then this tool would not be effective. It is important not to oversell the understanding of the oil and gas industry provided by this tool.
i. It would be helpful to more clearly explain the learning goals of the tool.
ii. For those areas not covered by the tool, it would be helpful to have links to those areas.
b. If the goal was to learn how a product gets to market and the technologies that are used along the value chain, then this tool does a commendable job. It is clear what is involved to move the product from one stage to the next.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

1. The ability to simply click on an aspect of the tool and not download any documents would be a market improvement on the current model.

2. It is uncertain where the links appear in the model. The links listed here, http://osiocs.clearstone.ca:60080/links.html, were not able to be found at many of the nodes that I was able to explore. Having relevant links for each specific node would help the tool to provide additional perspectives and resources to model users.

3. It was helpful to have the option of not going through the flow diagram to access a list of control technologies, etc.

4. Having a search feature would be very helpful for those users who do not have a basic understanding of the industry. For instance, if one wanted to know more about tailings but did not know that is only part of the oil sands mining industry, a search feature would be able to direct the user towards the relevant section of the tool.

5. Videos on relevant sections would greatly enhance the user experience, especially a video outlining the basic steps in the flow diagrams and some of the major challenges facing the industry.

C. Model Structure

The current model intends to include information against these main Categories:
Flow Diagram
Industry Description
Control Technologies
Projects
Air Issues R&D
Glossary of Terms

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a “cold eyes” perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

1. The current way to search the model is to use the flow diagrams to visually scan the supply chain, enabling users to select a node that interests them. This methodology works well for those who have a basic understanding of the system but does not serve well those who do not have a basic understanding. For instance, if someone wanted to know more about tailings management, they would have to know to look under oil sands mining and not in-situ or gas extraction, etc. Currently if one is interested in air emissions management, they would have to look at dozens of nodes to see the relevant information.

a. An alternative or supplemental format would be to organize information around interest areas. For example, if a user was interested in solid waste management or air

emissions management, they could search a flow diagram that tracked issues rather than product development.

2. Air Issues R&D – While it is essential to have this category in the model, it is also critical to have categories on land and water issues, as well as reclamation. It would be helpful to have a flow diagram for reclamation so that users can understand how industry intends to manage the land once the resource has been extracted.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

1. The current scope is already quite large. It is better to narrow the scope of the model and do a more thorough job than begin expanding to the chemical industry. You may want to consider even paring down the scope to just conventional oil or oil sands or natural gas. If a user is having to learn about all three industries then a less detailed overview will be needed; whereas, if the model is focused on only one industry then a user would have the stamina to explore in-depth about that industry. Even when one looks at the flow diagrams for the oil and gas industry overview, the diagrams could be considered cluttered and overwhelming for some users.

E. Model Detailed Content

1. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.

Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

a. Air emission issues are certainly important to include in the model. It is critical that land and water issues be included in this and/or future versions of the model. If this model is to be used for educational purposes, then a balanced perspective must be presented. From an environmental viewpoint, only informing model users about air issues is like leaving out the upgrading component when explaining oil sands development. It is better to refer model users to another more complete resource on the environmental issues of the oil and gas industry than to only mention air emission issues.

b. Regulations certainly are an important component of the oil and gas industry, although it would be difficult to include them into the current model architecture as many of the regulations apply differently at different nodes. Adding regulatory information may

add more confusion and less clarity. Perhaps if there was a different component to this tool that was separate from the flow diagrams, regulatory information could be included.
c. There are thousands of technology vendors whose information could be input into the model. Vendor data would be useful to add if there was a way to QA/QC their data or at minimum to put a caveat on the information they provide. This model can help raise the profile of technologies that could potentially mitigate some of the environmental impacts caused by the oil and gas industry.
2. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

Using the 'Stand Alone Mining Production' flow diagram as a example:
Flow Diagram

1. While this diagram is useful to explain what happens to the bitumen, there is no context about what happens before an operating mine pit and what happens after the DilBit is shipped in a pipeline. Similarly there is no mention of what is done after a NST backfilled mining pit is created or what happens to the MFT that cannot be reclaimed (end pit lakes). It is essential that future users or students understand the broader context of the oil sands – what was there before and what will be there afterwards. Using a life-cycle approach to the flow diagrams would help to improve the model.
Industry Description
2. Granted, there is mention of indigenous landscapes and reclamation in this description. However, this information needs to included graphically. This model is considerably large and any information that provided in text, especially attached files, may be looked over due to the sheer number of nodes at play in the model.
Control Technologies
3. There are a host of control technologies that can be included at any node in the model. It is unclear why the technologies that are present were selected. Providing selection criteria (e.g. demonstrated at a commercial scale) would be helpful. Also, having to download a file to see the control technologies (for Oil Sands Mining and Transport) or other sections is too onerous and should be included simply on the page where the link to download the MS Word document is located. Having pictures or videos of the control technologies would be helpful as well.
Projects
4. Currently the available projects are in a variety of file formats. Project descriptions should include a standardized format and also list why a project is selected in this list. The user should know why they should open this file before selecting the link.
Air Issues R&D
5. From the 'Stand Alone Mining Production' it appears that Air Issues R&D are included in more detailed flow diagrams and in the less detailed Oil Sands Industry Overview. It's uncertain why this issue appears at only some of the levels of the model.
Glossary of Terms
6. It would be helpful if users could search the glossary for terms.

8.2 Reviewer No. 2

Nodal Analysis Model - Questions for Reviewers

A. Model Objective

11. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?
    a. Yes, I found the program to be an effective tool. The flow diagrams make it navigable for junior level personnel, and the volume of case studies and data make it a valuable tool for more experienced personnel.
12. Does the system contain the information you want (if not, what is missing)?
    a. I found it to be very thorough. You may want to also consider adding links or PDF's of relevant industry technical articles in a technical library
13. Can you find the information you want readily?
    a. Yes, I believe the flow diagrams and side bars make it easy to navigate
14. Does the model go into sufficient detail in the areas of interest?
    a. Yes. It seems to do a good job trying to address two very different audiences – those with very little knowledge on a subject – to those looking for project successes to learn from.
15. Would you be willing to contribute information to the model?
    a. Yes, where applicable
16. What parts of the model do you find most useful and what parts do you find least useful, and why?
    a. Most useful to research areas I have little experience in. Least useful in areas where the downloads are just labeled "Methane Reduction Project Number 1" or other generic names. I recommend giving a more detailed title to explain why that download is relevant (or at least what company and region the case was from)
17. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?
    a. Yes. The next step would be updated the line drawings of tank batteries, etc to a more user friendly graphical approach in line with the top tier drawings
18. Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?
    a. Yes, I believe it is an effective tool. I'm unsure how it helps technology vendors disseminate their information?
19. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?
    a. Yes, but you would probably need to break it up into several different blogs or chat rooms. Those interested in oil sands would probably not have a lot of interest in compressor seals, etc.

20. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.
    a. The tool achieves the overall objective. I would recommend adding presentations and case studies / white papers from industry that are not run through a government program. Many times the case studies get so watered down by the time they make it to a Natural Gas STAR presentation that they lose much of their field value. It would require some form of vetting process to separate the wheat from the chaff, but I believe it would be beneficial for more sophisticated user groups.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

a. The incorporation of videos would be very beneficial, and would probably be the next step that I would recommend.

C. Model Structure

The current model intends to include information against these main Categories:

Flow Diagram
Industry Description
Control Technologies
Projects
Air Issues R&D
Glossary of Terms

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a “cold eyes” perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

a. Overall I was impressed with the ease to navigate. However, I did lock up when trying to download one of the case studies. The key will be to keep the information up to date and relevant.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

a. I think it's fine, but you may want to put in some qualifiers that this is a simplified version and the intent is to show an overview, not an exhaustive list of every potential vent source. For example, we are doing a project this month capturing a vent gas stream over 400 mcfd off produced water disposal tanks. This model doesn't show that any gas is released from the produced water. The same could be said for pipeline blowdowns, etc. This is a good 40,000 flyover view, but you may want to make that clear to the users.

E. Model Detailed Content

3. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.
    a. If you choose to do that, I would recommend that you handle those via a different site with similar structure and navigation tools.

    Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.
    b. You might consider adding links to training opportunities, workshops, etc

4. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.
    a. I don't have any major modifications to recommend. I would suggest moving forward with the analysis tool, with a commitment to modify and enhance it as user input is derived from the site. Some form of interface that is a live arena for users to offer comments and suggestions to improve the site will be important if you plan of the site reaching it's full potential. Overall, very nice job.

8.3 Reviewer No. 3

Nodal Analysis Model - Questions for Reviewers

A. Model Objective

21. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?

    Comments

    a. I like the graphical interface. I tend to focus on the pictures and think this might be the way most folks look at this initially. It would be nice to double click on the pictures to get to the control technologies associated with that category.
    b. I didn't see that grouping on the left until later, I suspect most folks will just click on the pictures in the overview first. When you click on the control technologies for Gas Processing I counted 63 topics – the alphabetical listing could be sorted by the way you have done it on the left under control technologies as an initial cut. Below was my first cut at gas processing (note I didn't see the way you grouped it until later, that would likely do it as well):

Orig Order	Unit Op	Description
3	Compressors and Engines	Automated Air/Fuel Ratio Controls
6	Compressors and Engines	Convert Engine Starting to Nitrogen
22	Compressors and Engines	Install Ejector
23	Compressors and Engines	Install Electric Compressors
24	Compressors and Engines	Install Electric Starters
32	Compressors and Engines	Methane Losses from Compressors
46	Compressors and Engines	Reduce the Frequency of Engine Starts with Gas
47	Compressors and Engines	Reducing Emissions When Taking Compressors Off-Line
48	Compressors and Engines	Reducing Emissions When Taking Compressors Off-Line
51	Compressors and Engines	Replace Gas Starters with Air
52	Compressors and Engines	Replace Ignition - Reduce False Starts
57	Compressors and Engines	Replacing Wet Seals with Dry Seals in Centrifugal Compressors
58	Compressors and Engines	Replacing Wet Seals with Dry Seals in Centrifugal Compressors
59	Compressors and Engines	Replacing Wet Seals with Dry Seals in Centrifugal Compressors
19	Consolidations & Evaluations	Eliminate Unnecessary Equipment and/or Systems
35	Consolidations & Evaluations	Nitrogen Rejection Unit Optimization Systems
36	Consolidations & Evaluations	Nitrogen Rejection Unit Optimization Systems
41	Consolidations & Evaluations	Process Optimization
4	Controls & Instrumentation	Close Main and Unit Valves Prior to Blowdown
2	Controls & Instrumentation	Automate Systems Operation to Reduce Venting
8	Controls & Instrumentation	Convert Gas-Driven Chemical Pumps to Instrument Air
11	Controls & Instrumentation	Design Isolation Valves to Minimize Gas Blowdown Volumes
21	Controls & Instrumentation	Install BASO® Valves
26	Controls & Instrumentation	Install Flow Valves
31	Controls & Instrumentation	Lower Purge Pressure for Shutdown Controls
43	Controls & Instrumentation	Redesign Blowdown Systems and Alter ESD Practices
44	Controls & Instrumentation	Redesign Blowdown Systems and Alter ESD Practices
45	Controls & Instrumentation	Reduce Frequency of Replacing Modules in Turbine Meters
49	Controls & Instrumentation	Replace Bi-Directional Orifice Metering with Ultrasonic Meters
50	Controls & Instrumentation	Replace Burst Plates with Secondary Relief Valves
56	Controls & Instrumentation	Replacing High-Bleed Pneumatics with Low-Bleed
60	Controls & Instrumentation	Scrubber Dump Valves
61	Controls & Instrumentation	Test and Repair Pressure Safety Valves
33	Dehydration	Natural Gas Dehydrators

34	Dehydration	Natural Gas Dehydrators
37	Dehydration	Optimize Glycol Circulation and Install of Flash Tank Separators in Dehydrators
40	Dehydration	Pipe Glycol Dehydrator to Vapor Recovery Unit
53	Dehydration	Replacing Gas-Assisted Glycol Pumps with Electric Pumps
54	Dehydration	Replacing Glycol Dehydrators with Desiccant Dehydrators
55	Dehydration	Replacing Glycol Dehydrators with Desiccant Dehydrators
63	Dehydration	Zero Emissions Dehydrators
25	Flares	Install Electronic Flare Ignition Devices
12	Fugitives	Directed Inspection and Maintenance at Gas Processing Plants and Booster Station
13	Fugitives	Directed Inspection and Maintenance at Gas Processing Plants and Booster Station
14	Fugitives	Directed Inspection and Maintenance with Optical Imaging
15	Fugitives	Directed Inspection and Maintenance with Optical Imaging
16	Fugitives	Directed Inspection and Maintenance with Optical Imaging
17	Fugitives	Directed Inspection and Maintenance with Optical Imaging
18	Fugitives	Directed Inspection and Maintenance with Optical Imaging
20	Fugitives	Inspect and Repair Compressor Station Blowdown Valves
62	Fugitives	Use Ultrasound to Identify Leaks
7	Pneumatics	Convert Gas Pneumatic Controls to Instrument Air
9	Pneumatics	Convert Pneumatics to Mechanical Controls
38	Pneumatics	Options for Reducing Methane Emissions From Pneumatic Devices in the Natural
39	Pneumatics	Options for Reducing Methane Emissions From Pneumatic Devices in the Natural
30	Refrigeration	Liquefied Natural Gas Emissions Reduction Opportunities
1	Srec/AGI	Acid Gas Removal
5	Tanks	Consolidate Crude Oil Production and Water Storage Tanks
10	Tanks	Convert Water Tank Blanket from Natural Gas to Produced CO 2 Gas
27	Tanks	Install Pressurized Storage of Condensate
28	Tanks	Installing Vapor Recovery Units on Crude Oil Storage Tanks
29	Tanks	Installing Vapor Recovery Units on Crude Oil Storage Tanks
42	Tanks	Recycle Line Recovers Gas During Condensate Loading

c. When I go into projects I wasn't sure what this was meant to do … the description was – Project One, Two, Three etc … perhaps this area isn't populated yet? Not sure of the difference between projects and control technologies.

22. Does the system contain the information you want (if not, what is missing)?
    a. Would be nice to direct folks to bmps that have been developed for other jurisdictions
    b. Perhaps a link to the ERCB too?? … a couple of ERCB web pages that you may want to link to are the "energy efficiency" and "flaring and venting" pages

       http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_240_2583201_0_0_18/

       http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_323_253_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/industry_zone/rules__regulations__requirements/flaring/
    c. I think it would be useful to see what other states and governments are doing for regulations.

23. Can you find the information you want readily?

a. It's a lot better using this interface over the typical results you get when you use search tools on web sites
b. Would be nice to be able to drill down to control technologies with each control technology differentiated and made unique – while this will require someone to maintain this system and pay particular value to the naming of files I think the value added would be huge! This would help those folks that use the info more than once ie it makes it easier for them to find the same info again.

c. The list of control technologies associated with some of these pictures in the overview is a bit big to be user friendly (eg. Gas Processing) You have grouped it by subject area under the control technology on the left side of the screen, you could use the same groupings for the picture under Gas Processing although I think even that grouping could be improved. I look at "Conduct DI&M at Remote Sites" and then under "Directed Inspection and Maintenance with Optical Imaging" and there are 6 files with the same title (although two of the links don't work) – would be useful to differentiate a bit more in the title so I don't have to go through 6 files to see what the differences are (Pres=Presentation, Prt Update = Partner Update, Fact Sheet, etc.). Every file at this level should be unique and some thought be given to the naming and example is given below:

   i. Dir Insp and Maint with Optical Image – Pres Angel Service
   ii. Dir Insp and Maint with Optical Image – Part Update Dynegy
   iii. Dir Insp and Maint with Optical Image – Pres Heath Consult
   iv. Dir Insp and Maint with Optical Image – Part Update Angel Service

   If certain types of info tends to be more useful perhaps that could be sorted to the front e.g. are factsheets better quality info typically?

   I think if partner updates are used it should be clear what article is being pointed to in it.

   Another way that might be used to differentiate types of info is by changing the icon associated with the file (rather than defaulting to pdf)

   You might want to consider tracking the site use and having a top 10 list for hits in last 3 months for control technologies. See what others are finding useful.

24. Does the model go into sufficient detail in the areas of interest?
    I think a schematic would add a lot to the information when its presented in the fact sheets e.g. Install velocity tubing strings Fact Sheet No. 704 – show a picture
25. Would you be willing to contribute information to the model?
    a. Perhaps a section could be made for regulators which could be linked to various documents that they have produced. Likely a separate structure than what has been developed here. Could include sections relating to regulations regarding flaring, venting, measurement, storage, fugitives, etc.
26. What parts of the model do you find most useful and what parts do you find least useful, and why?

27. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?
    I like the pictures and like the flow diagram of the Oil and Gas Industry – this would be my preferred approach to navigate the site … but would really like to see a bit more detail … even to click on gas processing and have an option to see a pfd would be useful. It looks like there is more detail on the figures for the Crude Oil Production – I would like to see the same on the Natural Gas System. When I click on gas processing I keep expecting to see a link to a pfd on a gas plant …
28. Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?
    I think it is more efficient and does improve access to the info. I think more work on the indexing of the info would improve it. As folks add info to it, the information and how it is indexed should be monitored closely and tweaked as needed – areas of higher use should likely be more prominent or emphasized.
29. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?
    I think a tool to encourage sharing of info between regulators state, provincial, and federal on flaring and venting etc. would be a good thing … might need to be structured a bit differently than by type of equipment as I suggested in 5.

30. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.

    I like the Flow Diagram of the Oil and Gas Industry and the ability to pull up info quickly off of this diagram.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

I think it works well with the current interface.

C. Model Structure

The current model intends to include information against these main Categories:

These should be the main ones
Flow Diagram
Control Technologies
Air Issues R&D

I don't think these should have the same prominence
Industry Description
Projects
Glossary of Terms

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a "cold eyes" perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

I like the navigation between categories … notably Control Technologies and Oil & Gas Industry Overview. I would prefer to go into the Control Technologies when I double click on the Pictures in the Oil & Gas Overview.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

I think the scope is appropriate. Given the magnitude of oil sands production to the North American Market I think it makes sense to include.

E. Model Detailed Content

5. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.

   Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

I think it would make sense to give more consideration to other GHGs which are part of the upstream industry and include projects to improve energy efficiency and reduce fuel gas consumption and flaring.

6. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

   I think the main areas for me would be the Flow Diagram and the Control Technologies … I would elimate the project summary, glossary, and related link buttons on the right side of the page – two buttons is all you need. I think the Air Issues R&D would be a good addition and would consider Fuel Gas Efficiency as a possible addition.

8.4 Reviewer No. 4

Nodal Analysis Model - Questions for Reviewers
A. Model Objective

31. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?
    The program is easy to use especially from the flow sheet on the home page. The links and drop down menus are effective at taking the site visitor to more detailed information. Most of the more detailed information MS-WORD pages seem to be very preliminary drafts and, I don't think they are 'ready for "prime time". (See my comments on a sampling of the Word Documents under Section E below"). Bottom line for this question, the links work well, they take the visitor to the intended information, but the content of the target page(s) needs more work. Content needs further development for both a junior as well as more senior level staff.

32. Does the system contain the information you want (if not, what is missing)?
    Some sections have good information (LDAR pages, overview of oil sands mining, etc. but I think to be more useful more "staged" detail should be provided along with citations and links to other web sites, e.g. EPA CHIEF, AP-42, Tanks etc.

33. Can you find the information you want readily?

See note 1 above, the links seem to work, the kind of information in the drop down menus from the home page flow sheet work well. Note, when using the menu list on the left side of the home page rather than the flow sheet, the "return to block flow diagram" button acts like the back key, it does not take the visitor to the home page flow diagram, it simply goes to the precious page.

34. Does the model go into sufficient detail in the areas of interest?

No. I think this concept is excellent and with more work could prove to be a very useful and more importantly "used" tool by students, government and NGO's , new employees, journalists etc. But, I think the content needs a lot of work. I think the information should be staged, say a page or two with sketches with high level (high school) descriptions of the topic under consideration, then a "more" button" that leads to more detailed info, say for a new employee with technical college or some engineering training, and if funding is available, another "more" button with advanced and detailed info suitable for senior staff. The latter would be useful to experienced persons being transferred to new assignments, say from refining to gas production.

35. Would you be willing to contribute information to the model?

Yes, I see lots of opportunity for me to contribute to further development of the content pages for some, but not all, sectors of the O&G industry. I could act as a "reviewer" for sectors in which I have no direct experience.

36. What parts of the model do you find most useful and what parts do you find least useful, and why?

I have not worked in all sectors of the O&G industry, so the overview sections are of interest, although I would like to see more detail. The emissions sections, and discussion of industry issues and challenges is of interest, but more content needs to be provided.

Once content is addressed, I think the usefulness will be provided via the block diagrams and links, which are already reasonably well developed. I think effort has to be placed on making the tool less dependant on the visitor understanding our jargon. The glossary page will help.

37. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?

The home page block diagram graphic is good and effectively illustrates the high level components of the O&G industry. I think the photographs were a nice and useful addition, need to add more, particularly on the WORD documents along with sketches.

However, the refinery flow sheet was totally non-legible. I think a simple block diagram of a refinery would be better. Then links to more detailed "typical" flow sheets for each process could be provided by clicking on the unit. E.g. clicking on the CCR on the refinery block diagram would take the visitor to a "typical" continuous catalytic reformer" flow sheet. Of course explanatory text would need to be available for each flow sheet. More detailed information around economics, product slate, opex etc could be provided in the third level i.e. detailed, of information targeting the senior staff audience.

38. Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?

I think when finished, this could be a very efficient vehicle to provide information on the O&G industry. I am not aware of similar public domain tools so cannot comment. I think a key advantage to this site is that it could be seen as independent of direct ties to the industry and therefore have more credibility than similar information provided by CAPP, CPPI, API etc. The Wikapedia page for

Petroleum industry is pretty good and easy to navigate. Again, it does not deal thoroughly with "Issues"..http://en.wikipedia.org/wiki/Petroleum_industry

39. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?

It could be, but before making it available for that purpose I think a lot more work needs to be done on the content part. In any case, I think there would need to be a commitment for long term staff support to edit, verify and screen contributions if this were to be turned into an interactive tool.

40. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.

Add an opening web page with introduction, objective etc. rather than launch the site visitor directly into the tool. As built, the site designers must assume that visitors understand our jargon. If they do not they will not know what to look for. The "new" opening page could include a link to a glossary page with search capabilities to allow lay persons/students etc. understand terms so that their search could be more effective.

I suggest we specifically add "Jounalists" to our target audiendce. The media seems to be woefully un-informed about our industry, which doesn't stop them from providing opinions and commentary that is sometimes less than accurate.

Add an "ISSUES" link to sections of the data base
Add "pre-requisite" reading statement to reduce opportunities for out of context understanding

The "Read More" links open an MS Word document. I suggest this be altered to a PDF file to minimize risk of hostile visitors hacking the system and adding un wanted content or changing content.

Not clear about the technical level of the intended audience. The documents I looked at use lots of jargon and, although not technically rigorous, process concepts that would require at least a couple of years of post secondary training or industry experience. E.g. look at the water treatment section,

How about suggesting a "course" of links that would automatically take the visitor through the appropriate pages, or down load a selection of WORD documents that would answer a query by the visitor. For example; What is SAGD? The macro would then suggest the following links/pages:
A

B
C
If the reader agrees then the macro would take the reader to the links and download the word or PDF documents for further reading by the visitor.

Provide references/citations

"*Back to Diagram*" button acts like the "back key" on IE, it does not take you back to the diagram, it takes you to the previous web page, which may not be the diagram.

Add sketches, diagrams and tables to the Word documents.

Need to include a discussion of GHG intensity and absolute GHG emissions. Given that issues are to be limited to air for now, need to include LCA discussion and how oil sands "wells to wheels" results. Since the oil sands inspired wells to wheels work compared a variety of crudes, conventional, hard to get conventional, etc. LCA data for a variety of crude pathways to market is available. Explain GHG intensity for crude, then refined products and finally after the consumer uses the fuel.

Need to include a discussion on water issues associated with extraction technologies, particulary oil sands. Secondary and tertiary oil production is much more water intense than oil sands. Bio-fuels, particularly crop based bio fuels are orders of magnitude more water intense than petroleum derived fuels. In a water supply challenged world this point needs to be discussed.

Discuss trend to ship raw bitumen (as dilbit or synbit) to the US for upgrading /refining rather than upgrade to SCO in Canada. Driven by economic advantage offered by modifying/expanding large existing US refineries rather than building dedicated upgraders. Issue is that host country (US) and host state will enjoy economic benefits associated with adding value to the bitumen while Canadians will be left with the environmental legacies and resource depletion not to mention GHG emissions while arguably not getting the social (employment) and economic benefits. Upgrading footprint is low while adding significant value, technology development and innovation opportunities in Canada.

Should there be a discussion of royalties? We here frequently in the media about how the O&G industry is heavily subsidized. Myth or reality? Could this be included as part of the O&G industry information library being proposed?

Several sections in the various O&G overview sections include redundant discussions on venting, flaring, tank emissions etc.. Suggest that these discussions be standardized and located under an "ISSUES - Emissions to air" menu item. Then specifics of releases to air applicable to each process can be discussed under the specific process with a cross reference to the generalities of, say flaring, which would be under the "emissions to air menu" Under that heading "emissions to air menu" could discuss elevated jet flares, ground flares, shrouded ground flares, flare specific design features like ignitors, flame front generators, knock out drums, steam assist, air assist…….Allows for a generalized discussion of the overall purpose of flaring, safety, conversion of toxics to less toxic substances (H_2S to SO_2which has a higher allowable max conc at the POI), conversion of CH_4 to CO_2 which has lower GHG potential etc.

Flare reporting, flare minimization programs and legislation could be discussed in the general section.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

No. Spend scarce $$ on quality content, add dazzle later if money is available and there is a consensus |(among???) that it is worth the investment.

C. Model Structure

The current model intends to include information against these main Categories:

Flow Diagram
Industry Description
Control Technologies
Projects
Air Issues and related R&D

Glossary of Terms
Suggest that over time we add:

- GHG issues and related R&D (although air related, I think this needs to be a separate category. Needs to include LCA, abatement technologies and reference to Mckenzie or comparable abatement curves.
- Water Issues and related R&D
- Land/waste issues and related R&D
- NOTE: each of the |ssues pages could include regulatory challenges, existing and anticipated, but would require an ongoing commitment to staff resources to maintain.

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a “cold eyes” perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently. The navigation through various categories worked well with the exception of the “back to diagram” button as mentioned earlier.

However, I think that a novice user, not familiar with our jargon might get lost unless they were simply “surfing”.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.
I think the feed stock varieties, technology platforms and product slate in use by the chemical industry is far more diverse and broad than the O&G industry. Therefore I think adding the chemical industry before the O&G industry is complete and ready for "prime time" would be a strategic error unless a lot of resources are available to implement. For now I suggest we focus on O&G.

E. Model Detailed Content

7. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.

Agree, but suggest maintain focus on air until the model is complete to the to "run & maintain" state
I think we need to be careful with vendor data, we shouldn't want to be seen to be endorsing particular vendors. Suitable disclaimers should be included where vendors are named. We should provide information on available and maybe emerging technologies with links to vendors. Let the vendors make their own claims on their web sites.

Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

- Add a section on waste water treatment/management
- Add a section on water consumption
- Add a section on waste management, include more detail on disposal wells so that the reader can appreciate and understand why disposal wells present little if any risk to drinking water aquifers.
- Add a section on land use issues for each type of process
- Add a section to deal with sulphur, hazards of H2S, Sulphur recovery and sulphur markets

If resources are available we should add fate of products. Journalists and interested audiences should be clear that the vast majority of emissions to air are related to end use, not extraction and processing of the resource, .ie. life cycle analysis results.

Water issues need to also be included, water is a major and growing global concern. First generation bio-fuels compare poorly with petroleum fuels in water use.

Provide references/citations for all non-generic information

8. Please advise what you would like to see modified or added under each of the
9. descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

INDUSTRY DESCRIPTION
Oil and Gas Industry Overview

Needs more detail on most pages plus some additional topics that I think are important and I didn't find.
Example, Storage caverns – under storage section. Also take the opportunity to explain that abandoned storage caverns are not seen as candidates for storing carbon as in sequestration.

Oil and gas geology, types of formations, extraction opportunity from primary (~30%), secondary (~30 – 40%) and tertiary (40+%) of the resource in place.

Provide an explanation of reserve types,i.e. reserves in place, proven reserves, recoverable reserves, probable reserves etc.

Include a discussion on "conventional oil and gas" vs. unconventional. Explain why oil sands, @~10 or so % HC in soil matrix, vs shale oil @~2 or 3% is more expensive to produce than conventional oil (e.g. Spindletop). Talk about heavy oil such as Venezualan Heavy or California heavy crudes, Mayan, deep offshore ect. although considered "conventional" are almost as energy intensive and expensive to produce as "unconventional".

Discuss energy return on investment (ERoI). i.e. Spindletop produced 20+ GJ of useable oil product energy for every GJ of energy input. Oil Sands produces ~5 GJ /GJ of input, shale oil is somewhat lower than oil sands.

Stand Alone Upgrading

> Stand Alone Upgrading takes the visitor to a short discussion on hydrogen manufacture.
> http://osiocs.clearstone.ca:60080/industryDescriptionDiagram.aspx?menuid=60

This section is an appropriate entry for upgraders but should also be added to the Refinery section, which is currently blank. Of course sections need to be written for all the process listed.,

I think one reason that mines were integrated with upgraders at the mine site was, in part, because in the early days of the mineable oil sands business extraction/froth treatment technologies could not reduce the clay content of the dilbit (bs&w?) to pipeline specs. Improvements in extraction/froth treatment technology now make meeting pipeline specs possible. The first to use the technology was Albian/Shell. The more effective technology, combined with a paraffinic solvent, made pipelineable dilbit and remote upgraders possible

along with adding residue hydro-conversion technology to coker technology as technology platform options.

Add cogeneration to the Upgrader process description as many facilities employ cogens and future units are likely to use cogeneration as cogens are one of the more cost effective ways to reduce GHG intensity. Also consider adding gasification because Opti Nexen is using Shell gasification and Northwest Upgrading will have a gasifier (Lurgi I think). Low natural gas prices will affect deployment of future gasifiers, but may be offset by limpact of California gasoline carbon intensity (AB32) regs. Because gasifiers (oxygen blown) are good candidates for carbon capture.

Under the sub-heading "***Purpose of Upgrading – main drivers":*** add a lead in sentence ahead of the bullet list that states the purpose of upgrading is to add economic value to the bitumen. Eg. "The following list of upgrades to the bitumen makes the SCO less expensive to process in a refinery, improves the refinery product slate and product yields as well as makes the product SCO acceptable to a much wider range of customer refineries." Then introduce the bullet list of process used to add value to the bitumen.

Oil Sands/Shale Oil Mining, Extraction and In situ Production

Add headings to separate topics. This article starts with a discussion of mined oil sands froth treatment technology and then shifts, without explaining that the subject is changing, to in-situ technologies. If the reader is unfamiliar witht the technology I think they may not realize that the technology applies to resources deeper than ~75m and become confused. The paragraph should start by stating that when the resource is too deep to be mined in-situ methods are employed.

Is it true that associated gas is flared as a normal process option as is implied on page 2/3?

Add a table to augment the discussion on page 2/3 regarding PEI and PCI.

Include steam to oil ratio, GHG intensity, energy return on investment

Include a discussion and comparison of water requirements for each recovery process as well as land disturbance requirements. Mining needs to address tailings issues.

Title of this section includes Shale Oil. Either add a discussion of how shale oil resources are exploited or remove it from the title.

I suggest that this section be restricted to resource extraction technologies with a cross reference to Upgrading rather than include upgrading in this section.

Refinery and Petrochemical Plants/*Control Technologies*

Rename the ***Directed Inspection and Maintenance with Optical Imaging*** headings to reflect the linked PDF files. I,e, there are two links to LDAR, one a slide presentation and one a brochure type document. Renaming the headers to reflect the pdf contents will make it easier for the visitor to find what they are looking for. I also suggest that topics such as LDAR, emission estimating techniques, emission factors be discussed under a general section as described above

with cross references from each industrial; process section. Refinery section should include links to the US-EPA Chief site, AP-42 etc. Similarly for Tanks model.

Refined Products Transportation, Storage and Distribution
This section discusses "Crude Oil Systems", "Loading and Unloading Evaporative Losses" and "Storager Losses". I don't think a visitor looking for "Crude Oil Systems" would intuitively look under "Refined Products". This section should includen a discussion about petroleum refinery products, maybe a discussion on fuel specifications, marketing terminals, issues with ethanol and how it is blended into gasoline, storage tanks with cross references to a general "Issues" section dealing with vapour controls.

Then issues specific to transportation, storage, distribution including retail can be addressed. Consider adding air issues associated with vapour controls on vehicles. This "product fate" section should include life cycle analysis results for transportation fuels since a lot of public domain work is available on this topic.

8.5 Reviewer No. 5

Nodal Analysis Model - Questions for Reviewers
Input Provided by Bruce Peachey, FCIC, P.Eng., New Paradigm Engineering Ltd.
Contact – 780-448-9195; newparadigm@shaw.ca

A. Model Objective

41. **Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?**
    a. I found the initial and subsequent flow diagrams useful for visualizing the large scale system but you get lost as you go deeper into the more blueprint like flow diagrams or in the sections without flow diagrams. The flowcharts at each sub-level in themselves are very valuable to junior staff and other stakeholders, so completing these for all areas should be a priority, even if the content at lower levels is not complete.
       [RW - Bruce makes several comments throughout on the inconsistency of information across levels in the current model – this indeed is the case and consistency is an objective that needs to be worked on].
    b. Not sure flaring/venting and water should be on the first level flow chart as they are part of and different in nature for each of the other parts of the process and we wouldn't/don't do them if we don't have to. i.e. they are not a basic and required process step for oil and gas production but are a unit operation like pumping that is in all steps, but the characteristics of the pumping , flaring and water issues change with the type of facility/resource. "Geophysical Exploration", "Resource Characterization", and "Exploratory Drilling" would be better things to include in the main flow. [RW – Addition of an Exploration module is recommended here]
    c. Even under oil well and gas wells you need a new diagrams showing drilling, completion, artificial lift, well leases, field gathering, field emissions, water

impacts, land impacts etc that are specific to the wells. Then under a sub-node of drilling have a flowsheet to move to information about energy use, emissions, safety, technology and other issues that are appropriate to that sector and that activity. A junior person in a drilling department won't care nearly as much about what the emissions are at a gas plant as the emissions from a drilling or service rig or estimating haul truck emissions. [RW – Addition of a Drilling and Completions module is recommended here]

i. Gas wells flow chart – show types of more types of gas resources such as sour gas, sweet gas, associated gas (is not the same as solution gas as it is a gas cap in the same formation as an oil pool), solution gas, coal bed methane, shale gas, landfill gas, hydrates
ii. Sour gas flow chart – Hazards of H2S, sour gas release safety practices, specific needs for drilling sour gas, sour gas production, sour gas gathering, sour gas processing

[RW – Expansion of the gas industry sector is recommended here]

d. Repetitive nodes (e.g. flaring and venting) are frustrating when they apply to different sectors. Oil vent and flares are quite different from gas plant flares and incinerators. Oil well test flaring is short-term, relatively low volume but more likely to be sooty and contain contaminants. Venting of sweet methane for cold heavy oil production is very different from venting sour gas from a thermal oil sands operation.

42. Does the system contain the information you want (if not, what is missing)?

a. Most people in the industry would like to be able to find cost, capacity or some type of other information in the nodes e.g. Some junior people don't know how to even guess at what an oil or gas well might cost to drill. They certainly don't know what it might cost to mitigate a vent or flare. This may be too ambitious for this level, but some suggested examples are given below. [RW – In addition to being ambitious, cost information changes every year – updating would be a major exercise].
b. Understandably the main focus of environmental impacts is GHG emissions, but I think it needs to touch on all sustainability issues related to each of the final documents. E.g. oil well leases
    i. Land Impacts: describe their size, total land area impacted, and what they look like during drilling, vs. what they look like when operating. Lease construction methods in muskeg, swamps, farmland, forest?
    ii. Water impacts: Drainage, conditions related to release of water from leases, potential sources of water contamination from spills of oil, produced water, herbicides, well kill fluids.
    iii. Air impacts: Wind direction indicators and monitoring of sour gas wells, potential fugitive sources at individual well sites, well blowouts, emissions during well workovers.
    iv. Ecosystem impacts: Noise, human activity levels, reclamation, etc
    v. Economics: range of costs of building, maintaining and reclaiming leases in various regions. I teach oil and gas property evaluation to 4th year petroleum engineers and it is very hard to find these numbers anywhere, even order of magnitude or examples.

vi. Security impacts – How to protect assets, emergency response considerations, responses to major leaks or releases of specific substances, etc. e.g how do you respond to a CO2 leak vs. a methane leak.

[RW – It is correct that Environmental impacts/issues are not in the model as a separate node (as currently in the basic model as Industry Description, Control Technologies, etc.) There is no argument that this would be a positive enhancement to the model, but would require significant rework of the architecture and content (since some environmental aspects are imbedded in other descriptions). This should be taken forward as recommended future work under the Major category]

43. Can you find the information you want readily?

a. I got lost pretty quickly in the areas that didn't have a flowchart yet. Unfortunately I started off with one of those and just used the left had menu in resource description to move around. Took me a while to get back to the flowcharts.

b. I used the menu on the left side in industry description to go to other nodes, then when I hit the back to diagram button it just stepped back through the pages I'd been to rather than jumping back to the main flow diagram.

c. I was looking for some specific information e.g. venting from cold bitumen wells but it isn't a separate topic and takes a lot of reading to try and determine if it is in the generic common nodes.

[RW – We need to take these observations in hand. They are particularly important as we are encumbered by not having search capability.]

44. Does the model go into sufficient detail in the areas of interest?

a. Some of the oil sands mining areas there is more information than I need while other areas such as water disposal and reservoirs have almost nothing in them. Water disposal wells have some unique emissions issues? Flowback water from shale gas fracturing may contain H2S. The most important areas to add information for those in the industry are the environmental areas, which are not really well covered yet (except GHG and even it could be better). [RW – See above under 2(b).

b. In most cases you could have a large number of levels with increasing detail like that in the oil sands mining but I think we need to be more consistent in the level of detail and try and get all areas to the same level first before one goes deeper into detail. i.e. get flow charts for each area under the main diagram first, etc. Blue print type flow diagrams are too specific and might vary considerably between operators.[RW – this is one acknowledged area of inconsistency. I agree detailed PFD or MFD could be removed – these are artifacts of the MTM model, but we should await the opinions of the other reviewers. As for levels of description, I would recommend keeping oil sands as the template for ultimate level of detail – not all sectors will go to that level by their nature, e.g. Exploration.]

c. As indicated not enough specifics on vent, flare, water, land and other issues specific to a particular type of facility or production. Also need lists of solutions or possible solutions indicated for these. People in the industry came out of university or colleges trained in basic oil and gas technology not the environmental sciences so they need this type of information the most. Also some

guidance on how to select and environmental technology for a given environmental need.

45. Would you be willing to contribute information to the model?

a. Yes. I teach classes in "oil and gas property evaluation" covering resources, economics, technology, risks and policy issues related to various oil and gas assets (conventional and unconventional) and think it would be relatively easy to develop some materials that cover those areas.
b. Yes. I also teach and have done work on the relationships between energy, carbon and water for various sectors, so would be willing to help with those as well.
c. Links to reports in the detailed documents would help link experts to a lot of materials on line (like PTAC reports) that they otherwise would never hear about.

46. What parts of the model do you find most useful and what parts do you find least useful, and why?

a. For junior personnel a complete set of useful flowcharts of the main process and key impacts areas would be the most valuable.
    i. Detailed flowsheets of specific facilities least useful. Hard to read and junior people might be tempted to think the design shown is the only one used for that process or assume it is the best process. [RW – See above under 4(b)]
b. For more senior people links to the latest high level reports and studies on line would be the most valuable. E.g. latest/best quality information on how to calculate gas reserves in a shale gas or CBM deposit where the practices and standards are still in flux and not in any textbook. [RW – this would seem to be somewhat corporate specific and perhaps even proprietary. We need to decide if economics is a topic to be addressed, since costs, incentives, prices/revenues, payouts, etc. change from year to year].
    i. Least useful are generic descriptions that are too general to apply to any one situation. [RW – here we have the issue of "general" information vs detailed sector or technology specific information]

47. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?

a. Only first level and more general flow diagrams are useful. Detailed flowsheets not high enough quality on line and may indicate a preferred process design which is not the case. [RW – Again, see comment immediately above].
b. Need a complete set of 1-3rd node level flow diagrams so you can visually work through to the end point you want under all categories. [RW – agree]
c. Differentiate somehow which buttons lead to another level of flow diagrams and which end in descriptive documents.
d. All levels need visual graphics in documents that put information in perspective from different points of view. E.g. under oil sands the oil sands flow diagram might link to a descriptive chart or set of pie charts of various types for that resource that indicates the size of the resource in place relative to other oil deposits, show graphically how much oil sands can be recovered by each method, and air, GHG, water, land and energy intensity/efficiency indicators. E.g. only about 4% of the oilsands resources is accessible with surface mining but potential recovery is 70-80%, while 33% is accessible with thermal methods at 10-30% recovery and 9% accessible with conventional cold production but only 5-10%

will be recovered. These three areas also have very different intensities for energy, water, GHG, air emissions and land impacts. [RW – this is an excellent objective if the program can afford the expert man hours to develop this].

48. **Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?**
    a. **Finding information → yes.** PTAC has an initiative to try and educate SME [RW – what is SME?] innovators, service and supply companies about the oil and gas industry and this would be great for that. SMEs have a hard time selling technology into an industry they don't understand except through newspaper articles. The same is true for meeting the needs of government, NGO and other stakeholders.
    b. **Technology vendor and researchers dissemination of information → no.** I think we want to keep it clean and at a high enough level that we don't confuse people with competing claims of technology vendors that may have little or no scientific backing or highly scientific claims of promoting research which may or may not have practical application. Also this opens the site up to being swamped with ads, promotions and sales pitches or view points. I think we need to stick with high level generic facts that everyone (99% of experienced industry people in that area) agree with. Explaining the difference between CSS and SAG-D is relatively easy, sorting out claims of which one is better is a pandora's box of problems!
    c. **An example I hate.** Under oil well/control technologies are a couple of documents declaring "Green Flowback" and "Green Completions". We should avoid meaningless adjectives like this that are undefined. How many variant of "new and Improve TIDE laundry detergent" have there been where most of the change is in the packaging, colouring, or smell. [RW – I agree with this comment.]
49. **Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?**
    a. **Yes with caution** – The SPE has discussion forums and I find many of the questions are pretty basic and could be answered through further expansion of this tool if they aren't covered already. Only answer them once and answer them well with a consensus answer by experts, and make it easy to find the answers. Even examples experiences etc should come from a group consensus not just anybody's examples. E.g. the Process Safety Management Division of the CSChE has done work on risk assessments with LNG ship accidents, coal explosions, and refinery fires we should draw on those types of groups for examples.
    b. **Yes to posing questions** – Anyone should be able to submit a question, if it is one already addressed then somehow automatically, intelligently point people to it, if it is new and useful to others, trigger developing material to answer it for everyone.
    c. **No to a free and open forum** – There are enough blogs and other discussion groups around where the discussions go on forever without resolution. This site should stick to facts and knowledge not debates. Leave those for others with time

to burn. Also want to avoid secret areas or pass word access areas, it needs to be perceived as being an open knowledge site.

50. **The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.**
    a. **User-friendly, e-learning tool → Yes** it will meet these objectives very well and serve a very valuable function as long as it is maintained and not just a theme of the month or a one off project with limited life. i.e. it needs decadal funding and commitment of people to support it.
    b. **Information management and project tracking → No.** I just had a Petroleum Engineer student ask me if there was one central site to go to to find oil and gas statistics, mergers and acquisitions, projects, reservoir information etc. I couldn't think of any and most of those areas are very expensive to develop so they are managed by specialized magazines, organization or regulators for their specific region, type of resource, discipline or interest. Trying to get this all in one place and keep it up to date would cost a fortune, detract from the focus on the learning tool aspect, and is generally already found in a tool called the internet! Information collection and management, and keeping track of thousands of projects is extremely costly and time consuming to keep them updated. Having said that if we could negotiate links to specific public data e.g. Oilsands Review list of projects, Oilweeks top 100 etc that might be useful if they are will to share. I subscribe to a lot of magazines, and get electronic updates on a lot of things of interest but there are thousands more out there, just too much information!

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

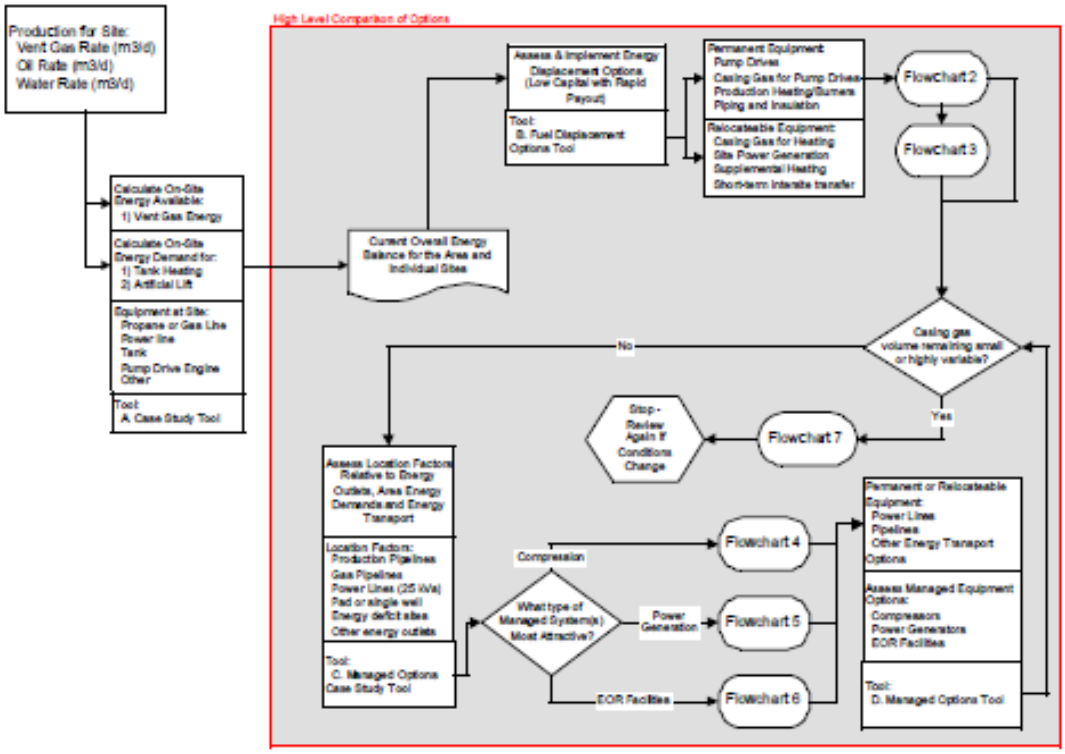
I'm not into this type of technical question, however, I think if we stick to it being a user friendly e-learning tool, then going to more advanced systems may work against us. We need something that is widely used by a lot of industries and organizations not something designed for track medical records and cut back to do something simple. Should follow the KISS principle.

C. Model Structure

The current model intends to include information against these main Categories:

Flow Diagram – These are great and should be the first priority to complete but at the generic level (no process flow diagrams) and enhanced by being more specific to an industry sector.
Industry Description – These have to be higher quality and more specific. A generic document on flaring and venting doesn't cut it as it isn't a necessary component and the attributes of this stream/equipment/unit operation change dramatically between sectors. I would make navigation solely based on the generic flow diagrams and get rid of the side bar menus to free up more room for information.
Control Technologies – These can be highly specific to the sector or generic. This is where the selling and advertising needs to be controlled. Most problems have more than one potential solution and there are better options in given situations. Also solutions should usually be considered in a logical order and/or not until after the basic problem has been better defined. E.g. don't need large vent compressors for flare systems if the operations don't have to flare in the first place. I find some of the control technology materials to be sales pitches with a bit of information [RW – Yes, and again this is a residual from the MTM model – we need to consider the recommendation of eliminating vendor input]. Would sooner see more generic flowsheets of potential options like ones I developed for vent gas emissions (see below) and let people find the local vendors of those types of options rather than having this site appear or be perceived as promoting one solution over another. Cetac-west best practices should be the preferred type of material. [RW – this approach requires further discussion. This sort of display may be too detailed, trending us toward an "expert system" approach, although I realize this may serve as learning information rather than something a user would actually take up. But, in what other technology areas in the model would this type of diagram be employed?]

Flowchart 1 - Current Situation Assessment Flowchart



Projects – Not sure what would be meant by this or how it would work, who would maintain it. E.g. we went from over thirteen new upgraders approved in the Edmonton area 18 months to maybe none now, hard to keep on top of those.

Air Issues R&D – Again tough to maintain and clearly communicate research. A lot of papers given at the Canadian Chemical Engineering Conference sound like they are solving all the problems in the world based on abstracts and then the talk indicates they are refining the determination of a known constant in an obscure process. Need to stick to high level and potentially indicate the parameters of a successful solution for s specific problem. i.e. method of catalytically destroying small amounts of VOC in a emission stream of methane at flow rates less than 50 m3/d at a cost of less than $5000 or <$5/tonne of material destroyed. [RW- Indeed, the main intent of this theme is to present needed R&D, as compared to detailing ongoing R&D programs].

Glossary of Terms – These are all pretty general. It would be much better if we could get an online seachable version of the "Dictionary for the Petroleum Industry" accessible online. I have the one published by the Petroleum Extension Service, Continuing and Extended Education, The University of Texas at Austin, 3rd edition 1999 that I bought through the SPE. Maybe we could pay them an annual fee to put it on-line and focus on adding to it and upgrading it with them rather than printing paper copies that are hard to use and keep current. [RW – this would have to be carefully evaluated. In particular the oil sands industry has specific technologies, hence technical terms, that may not be in another data base].

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a "cold eyes" perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

As indicated above I would try and stick with the flow diagrams for navigation rather than the side menus. My preference, but also I think it matches better what kids are doing with apps and computer games. Try and function with minimum words for navigation.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

I think we should take it as far as we can and at least include all the energy and organic chemical industries. Natural gas is being used more and more for power and interest is again being renewed in natural gas as a vehicle fuel. People are starting to get more serious about widespread coal liquefaction or gasification, or gas liquefaction, bio fuels, landfill gas, etc. Husky has an ethanol plant at their upgrader and ethanol is becoming a mandated component of gasoline. People are working on research projects for in-situ conversion of coal to petrochemicals and/or energy. Once you include those you might as well cover solar (a lot of people in oil and gas are gaining expertise), geothermal (still need wells for this), hydroelectric

and uranium, thorium, nuclear. Just need to pace ourselves and put priority on the oil and gas stuff first. [RW – I agree with this wisdom]

E. Model Detailed Content

10. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.
    a. **Yes to land, water, ecosystem, economic, security, health and safety** as indicated above this is an area where people in the industry really need to come up to speed fast!
    b. **Yes to links to regional regulators –** Too hard to be generic on regulations. E.g. California's Dept of Energy manages all clean renewable energy sources, but all their "dirty" thermal heavy oil production is under the jurisdiction of the Dept of Conservation.

    Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

    Might consider some opportunities to show sensitivities of oil and gas operations to various environmental, regulatory or fiscal conditions. Help people to understand how some specific changes impact the industry.

    In my oil and gas property evaluation classes I have teams of students do case studies to show how various factors impact properties from the point of view of reserves, economics, technology, risk (includes environmental), and policy (governments or corporate), some of these might be used to do professionally and add to the content. E.g. all other things being equal what is the impact of doubling the SOR in a SAG-D operation? Or how much royalty money would Newfoundland have received from Hibernia if they used the oil sands royalty formula? How does the cost of carbon capture and storage change if the aquifer you inject into is closed and water has to be pumped out to make room for the CO2? [RW- this again considers economic evaluations (commented on earlier) which are excellent classroom exercises but may not be workable as an ongoing topic in this learning tool].

11. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

I think I have done some of that above. E.g. oil wells get into drilling, cover all activities from geophysical exploration, geologic interpretation, and exploratory drilling, coring, logging, passive or 4-D seismic etc.

8.6 Reviewer No. 6

Nodal Analysis Model - Questions for Reviewers

A. Model Objective

51. Is the program an effective easy-to-use e-learning tool than can be used by both junior and senior level staff as a source of introductory and advanced information relating to the oil and gas industry (i.e., can you find what you want readily)?
    a. Generally yes. Some web interface improvements would be helpful, but undoubtedly these would be done in any case prior to the site going live.
52. Does the system contain the information you want (if not, what is missing)?
    a. Links for words that are defined would be helpful (i.e. in the glossary for field natural gas, to hyperlink to the definition of dehydration which is under gas production and processing)
53. Can you find the information you want readily?
    a. See 2a above
    b. The left side menu bar for definitions could use some formatting to make sure the hierarchy is evident to the user.
54. Does the model go into sufficient detail in the areas of interest?
    a. For me, yes, however for specialists in the industry, I could see that at least another level of detail would be required.
55. Would you be willing to contribute information to the model?
    a. I probably don't have much information to add – unless it is to WCI quantification methods for GHG emissions
56. What parts of the model do you find most useful and what parts do you find least useful, and why?
    a. Flow diagrams and definitions will likely be the most useful
57. Is the quality and sophistication of the graphics adequate (i.e., flow diagrams, icons, photographs), and if not how could they be improved?
    a. In the most part, yes. However some of the more detailed flow diagrams (i.e. dehydration) may be too detailed for the general user – generalized versions of these could be useful.
58. Does the program serve as a more efficient means than traditional search engines for end-users to find oil & gas industry specific information, and for technology vendors and researchers to disseminate their information to the intended end-users?
    a. Definitely yes.
59. Would you see this as being an interactive tool for posing questions and sharing information (e.g., technologies, research, regulations and best practices, experiences, lessons learned, etc)?
60. The initial objective of the nodal analysis tool was to provide a user-friendly, e-learning utility, information management tool and project tracking utility that could be

incorporated into government, industry and learning institution basic training programs, primarily accessible by individuals on the internet. In your view does the model generally respond to this objective as it is built, as it is or is not user friendly, and as it may contain relevant information. Consider your input here from an overall perspective, as there is opportunity to comment on specifics on some of the following questions. Please provide any suggestions you may have for modifications or improvements.

a. Yes, it will serve this purpose.

B. Model Architecture

The current nodal analysis tool is essentially a proof-of-concept application as first developed collaboratively by USEPA and industry. The architecture used at the time consists of MS Access as the underlying database. It is recognized there are more robust versions of graphic interface software that could be applied, with greatly enhanced graphics and search features. However, budget limitations may preclude moving from the current data base approach. Please give your opinions on this issue.

C. Model Structure

The current model intends to include information against these main Categories:

Flow Diagram
Industry Description
Control Technologies
Projects
Air Issues R&D
Glossary of Terms

Please comment on the ease of navigation amongst the various categories, taking into consideration your experience after addressing the model from a "cold eyes" perspective, and considering your view on how new and less experienced users may be able to perform searches, first time and subsequently.

D. Model Scope

The model currently tries to address the overall Oil (including Oil Sands) and Natural Gas industries. The Oil industry scope includes description of the industry from production through refined products marketing, with the prospect of also including the Chemical industry. Please comment on whether you believe this scope is appropriate.

E. Model Detailed Content

12. The model currently focuses on air emissions, an artifact of the initial Methane to Markets project objective of GHG controls, plus the subsequent added impetus NRCan has placed on all air emissions (to include additional CAC's and HAP's). It has been

suggested that land and water issues, regulations, and vendor data could be added in subsequent development of this tool. Please provide your comments on these proposals.

Also provide any comments on additional categories you believe would be useful and effective considering the objective of using the model for training purposes and dissemination of information.

13. Please advise what you would like to see modified or added under each of the descriptive categories (listed above under Section C) in the current model version. It is realized that in the time allowed, it would not be possible to examine each node in the total model in detail, but it is suggested to take a flow diagram of interest and comment on a series of nodes through the various levels.

9 APPENDIX 4 – TECHNICAL REVIEW OF THE NAT BY DR. DAN FIELD

9.1 Executive Summary

- The linkage structure of Node Analysis Tool appears to be very difficult to maintain, augment, and verify. Consideration should be made to creating a graphical link editor tool to simplify this process. A tool should also be built to perform link validation. Consideration should be given to scrapping the underlying database entirely.
- There is a great amount of code duplication in the html, aspx, and code-behind files which is a detriment to enhancing and maintaining the web site.
- Consideration should be made to eliminate the flash content as there is no actual animation and it causes difficulty for printing. SVG is a viable alternative which does not suffer from printing problems.
- The web site employs numerous data files of proprietary form (specifically MS Word). Many of these files are only one or two paragraphs in length. Users may not have access to these programs, these programs slow down site navigation, and they cause difficulty for search engine indexing. Consider replacing these document files directly with HTML pages or pdf files.
- The web site harbors an SQL injection vulnerability which should be repaired as soon as possible.

9.2 Introduction

As currently implemented, the Nodal Analysis Tool (and its associated web pages) presents diagrams and documents pertaining to the oil and gas industry. The information in the web site is presented in a top-down fashion allowing users to browse particular portions of the industry of interest and to drill down a number of levels of detail eventually ending up at detailed supporting documents.

This review was performed by extensively browsing the web site at http://osio.clearstone.ca. All supporting source documents including source code files and the underlying database tables were examined to gain an understanding of the architecture and implementation of the system. A number of independent reviews regarding the usability of the website were also read. That said, this review focuses on the architecture and implementation of the Nodal Analysis Tool and not so much on the content of the website.

9.3 Functionality

Users expect certain behaviors and functionalities when visiting modern day web sites. The two areas that are found to be lacking in this area are the ability to search among the pages hosted on the site. This is mostly a technical implementation issue: there are 3rd party systems available that can be used to build search capability into a web site though some may not be able to read and index from proprietary document formats (*e.g.* MS Word).
Printing functionality is somewhat limited due to do the extensive use of flash for the flow diagrams. I cannot see why flash would have been used as there are viable alternatives (for example *scalar vector graphics)* which, I would suspect, could have been created by whatever tool was being used by the artist that created those images in the first place. Flash would only

truly be useful if these diagrams were animated, but I suspect such animation might prove to be distracting and detract from the presentation.

Many of the web pages that are referenced by the Nodal Analysis Tool are dynamic and use dynamic linking—that is the actual addresses of the web pages aren't contained in other web pages: the links and other page content are assembled in the server prior to be sent to the web browser. This makes it difficult for search engines to locate the web pages on any site built with this tool. Consideration should be given to constructing and submitting *sitemap*[1] files directly to the major web search engines.

9.4 Usability & User Interface

Several user reviews mention some difficulty with the navigation through the site. I found this to be the case at the beginning: it isn't instantly clear what the relationship is between the expanded menu on the left column and the right-click items in the main body of the web page. This did all become clear shortly, but I still found it hard sometimes to read from the left menu exactly where I had navigated to in the hierarchy and how to move down to pages that were siblings of the parent of the current page. I believe adding a button which navigates backward in the hierarchy would help in this matter (several others commented on this as well). A site-map might also be worth considering.

Some thought should be put into how to clarify the information in the left menu area to see more easily the location in the hierarchy of the current page. Further, using some sort of breadcrumb indicator might also assist in this area. It is sometimes hard to navigate back to previously viewed pages (without going through the browser history).

The use of third-party applications to view documents (specifically MS Word and MS PowerPoint) is problematic. There are a large number of such documents in the web site that consist of nothing more than a short one or two paragraphs that don't justify launching a separate (and potentially unavailable) application. These should be re-written as plain html. Only when a document is not available in any other form should MS Word and MS PowerPoint be used. Consider translating these documents into pdf form (at least everyone will have access to reading pdf files). Documents of these types can also cause indexing difficulties for certain large search engines. These may also prove to be barriers for implementing local site-search functionality.

No attempt has been made to deal with internationalization (multi-lingual support) issues. Even if this is not a high priority at present, retro-fitting internationalization is typically a hard thing to do: there should be some initial planning for how one would maintain and support language catalogs and libraries of pages in different languages.

There is very good compliance in the use of alt tags for images on the site pages; less so for the flash diagrams. One simple thing that would help for blind users is to place a lang property in the html tags in order to facilitate automatic page reading. Unfortunately, I fear that the left menu area would be almost completely unusable by an unsighted person.

[1] A sitemap file contains an explicit list of the files that a web site would like to have a search engine crawl and index. As not all pages in a site are internally linked, this is the only mechanism that can be used to guarantee that the content of this site can be found by major search engines.

Finally, there are no error handler pages for this web site. Should you enter a malformed or unknown URL in the browser address bar, you will receive one of the default IIS error pages. It would be better to replace these with something that retains the look and feel of the web site.

9.5 Maintainability and Extendibility

This is the area of the Nodal Analysis tool that underwent the greatest scrutiny. Once I understood how the database tables were used to represent links across pages and how they were used to populate page content, it became clear to me that there was a lot of complexity here: too much really. I began to wonder about the following items:

- How hard it is to add new pages (specifically link these pages into the site)
- How hard it is to verify that mistakes weren't made editing the database tables and that there weren't hanging or misdirected links.
- What sort of task would it be to reorganize the linkage

I could only conclude that any of the above tasks would be painful and likely result in hard-to-find errors. The information about the links is represented inside a set of tables. While there are well-known techniques for embedding hierarchical, and one-to-many, and many-to-one link relationships in tabular format, the manner in which these tables must be structured obscures the actual relationship. These tables really should never have to be manually read or modified. The conclusion is that maintaining linkage information in this form is difficult to do and error-prone.
One solution is to build a front-end link-design system that would display the linkage and allow for links to be created, moved, and deleted using a graph-like interface. This interface would read the links from the database tables, build the display, and then write any edited link information back to the tables. The advantage here is that the person making link edit changes needn't worry about node numbers or column names, searching through columns for other numbers. This advantage would have to be offset by the effort required to produce such a program.
While the underlying representation of the link structure hasn't changed (it is still in tabular database form), the maintainability of the entire system would be increased dramatically. But I also question the use of a database to encode the link information in the first place. There is no reason why the link definitions could not be defined in a single text file (xml or otherwise formatted). The file format should be simple enough to visually see the relationships and use names rather than node numbers. The web site would then read this flat text file and construct an internal representation of the link structure in memory. This would eliminate the database component entirely and has the potential for speeding up page loading.
In any case, there is great need for a tool to verify the link structure.

9.5.1 Code Duplication

Reading through the html files, aspx, and code-behind pages, one discovers large amounts of code duplication. Perhaps the most important consequence of code duplication is that it can greatly increase the cost to augment and maintain the web site.

Take the html files for example. There are 96 such files. They all contain the same header, footer, left menu, and main body layout. Should you wish to do a facelift on the site (say change

the header icon), you now have 96 files to change. These files should be heavily templated so that all layout information is defined in a single location (file).

The aspx files also suffer from duplication. Not only do they contain the same layout, they also contain other duplicated templating information (see the main body content section).

The code-behind C# files also suffer from duplication. There should be a simple front-end built in C# that deals soley with the SQL querying and responses: this code should appear in a single file and the code-behind pages should be using this abstracted interface rather than processing SQL statements directly. This is similar to the idea of separating business logic from data representation.

9.6 Website Security

I have discovered that the Node Analysis Tool is vulnerable to SQL-injection attack. Fortunately, there is no user-sensitive data on this site, but there is the potential for a malicious hacker to delete all of the linkage information in the database tables which would bring the site down.
In order to fix this problem, the parameters sent as part of the URL should be properly tested and quote-protected if necessary. If a parameter is expected to contain only numerals, then that constraint should be enforced. Fixing this problem is straightforward.