

RECEIVED

JUN 01 2007



SENT TO COMPLIANCE REGISTRY
Hardcopy Electronically
of Copies 1 / Date 6.5.07

May 30, 2007

VIA CERTIFIED MAIL –
RETURN RECEIPT REQUESTED

Mr. Chris Hoidal
Director, Western Region
Pipeline and Hazardous Materials
Safety Administration
12300 W. Dakota Avenue
Suite 110
Lakewood, Colorado 80228

Re: CPF 5-2007-1002M

Mr. Hoidal:

On August 14 through 18, 2006 and August 28 through September 1, 2006, representatives of the Pipeline and Hazardous Materials Safety Administration (PHMSA) conducted a review of Kinder Morgan Inc.'s (KMI) Integrity Management Program in our Lakewood, Colorado offices. As a result of that review PHMSA offered constructive criticism and suggestions for improvement that KMI is incorporating in our program.

On March 5, 2007, PHMSA sent a Notice of Amendment to KMI requiring changes to three (3) specific areas of our Program. In order to maintain clarity in our response to PHMSA's requirements for amendment KMI will repeat the required amendment and immediately following provide our response in bold font. Our Response includes the section of text within our revised program where the specific addition to language that addresses the required change occurs.

At the suggestion of the PHMSA inspection team KMI is in the process of restructuring our entire Integrity Management program to correspond with PHMSA inspection protocols. The filing of our revised plan will be done in conformance with Federal Requirements (192.909(b)) and will be completed by September 30, 2007.

Item 1A: 192.911(h) and 192.937(b):

The KMI procedure for establishing when continual evaluations are needed do not explicitly require that a re-evaluation be conducted in response to significant leaks, failures, or incidents.

Mr. Chris Hoidal
Director, Western Region
Pipeline and Hazardous Materials
Safety Administration
May 30, 2007
Page 2

KMI Response:

Kinder Morgan has revised the IMP plan to clearly detail this requirement. Section 9.1 below describes the KM requirement for Continual Evaluations. Section 6.2.1.3 details how the information is obtained by the risk engineer to trigger this event.

9.1 Periodic Evaluations [192.937(b); Protocol F.01]

Subsequent to the baseline integrity assessment, KMI continues to assess the covered segment at intervals and periodically evaluates each covered pipeline segment's integrity.

Periodic evaluations are based on data integration and risk assessment (IMP Section 6, *Threat Identification, Data Integration, and Risk Assessment*) of the pipeline system. For transmission pipelines other than plastic pipelines, the evaluation will consider past and present integrity assessment results, data integration and risk assessment information, remediation decisions, and additional preventative and mitigative actions.

Periodic evaluation triggers include, but are not limited to, the completion of integrity assessments and data evaluation, substantial leaks, failures or incidents, and the availability of new integrity information. As with baseline assessments, reassessment method determinations are made in accordance with the particular threats for each segment.

Risk Engineering documents periodic evaluations and reassessment planning on ICAM. Documentation consists of decision making and rationale for reassessment planning.

Reassessment plans for KMI business units are reviewed by *Risk Engineering* annually to determine if new information of threats and pipeline conditions warrants changes to the reassessment plans. Pipeline segments are risk ranked annually in *PIRAMID*[™] by total combined impact as described in IMP Section 6.3, *Risk Assessment*. The risk ranked list is employed to re-evaluate the baseline assessment/reassessment plan for each KMI business unit. The annual risk evaluation and prioritization process is conducted in a similar manner as the initial risk ranking and prioritization process as described in IMP Section 5, *Baseline Assessment Plan*.

6.2.1.3 Incident Reporting Tools

STARS[™] is an on-line tool that stores various information related to a pipeline incident or damage. Information collected includes a brief description of the incident, pipeline system data, type of incident, and the incident cause. Data stored in the *STARS*[™] program is employed for determining reporting criteria and performing additional analysis on the affected segment when necessary. During the annual risk ranking process, *Risk Engineers* review *STARS*[™] incident data on covered segments.

Incident notifications are also received by the *Director of Risk Engineering* and the *Risk Engineer* responsible for the applicable pipeline system through the company Emergency Response Line (ERL) notification system immediately after the incident is reported.

Mr. Chris Hoidal
Director, Western Region
Pipeline and Hazardous Materials
Safety Administration
May 30, 2007
Page 3

Item 1B: 192.911(h) and 192.935(a):

IMP I 0070 provides a framework describing requirements for the P&M Measures program. However, KMI has not defined the detailed process steps used for identifying additional measures based on identified threats to each pipeline segment and the risk analysis.

KMI Response:

Kinder Morgan has revised the IMP plan to detail the process used for evaluating Preventive and Mitigative Measures. Section 11 describes the base process used and section 7 of the Risk Process Document details the steps taken. Due to the length of these sections KMI has included their entire text in the attached Appendix A.

Item 2A:

KMICD Lander Hudson Lateral was listed as an HCA in the 2004 BAP. This HCA was removed from the BAP in the 12/17/2005 BAP. KMI did not document the reason for change, authority for approving change, analysis of implications, or the communication of the change to affected parties.

KMI Response:

Kinder Morgan has revised the IMP plan to describe the process used to evaluate changes in HCAs. This process includes steps to validate the changes and generate an MOC related to the change. Section 4.6 describes this process. Also included is O&M 155 and form OM100-15-IMP that describe the Kinder Morgan MOC process. Due to the length of these sections KMI has included their entire text in the attached Appendix B.

4.6 Identification and Evaluation of Newly Identified HCAs, Program Requirements [192.905(c); Protocol A.06]

Continuing surveillance activities are provided in O&M Procedure 220, *Structure Survey for Class Location and HCA Determination*. New or changed HCA boundaries caused by changing pipeline conditions are identified and updated annually. Those changes include:

- Change in MAOP
- Pipeline modification including pipe diameter alteration
- Change in pipeline product
- Installation of new pipe
- Change in class location / location boundary
- Pipeline reroute, new pipeline
- Correction to pipeline centerline
- Field design changes
- Identification of new construction activity
- Change in the use of existing buildings

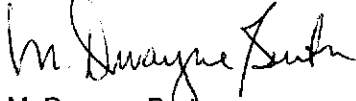
In addition to tasks performed in O&M Procedure 220, *Structure Survey for Class Location and HCA Determination*, and IPODS Engineering Standards, once each calendar year, *Engineering and Technical Services* will run the Petris software HCA Comparison Tool. This software uses the criteria in the bullet points above and

Mr. Chris Hoidal
Director, Western Region
Pipeline and Hazardous Materials
Safety Administration
May 30, 2007
Page 4

compares new or changed HCA boundaries to previously identified HCAs. This data is used by *Risk Engineering* to update the baseline assessment/reassessment plans in accordance with IMP Section 5.4, *New HCAs/Newly Installed Pipe, Newly Acquired Pipe*. This data is also used to validate the HCA changes and to develop an MOC for any changes to the BAP.

If you should have further questions regarding this response please do not hesitate to contact me.

Sincerely,



M. Dwayne Burton
Vice President, Gas Pipeline
Operations and Engineering
Kinder Morgan, Inc.
One Allen Center
500 Dallas Street
Suite 1000
Houston, TX 77002
(713) 369-9356

Appendix A

INTEGRITY MANAGEMENT PROGRAM

11. Preventive and Mitigative Measures

11.	Preventive and Mitigative Measures	1
11.0.	Introduction [Protocol Area H]	1
11.0.1.	Scope	1
11.0.2.	Responsibilities	1
11.0.3.	Associated KMI Procedures	2
11.1.	General Requirements [Protocol H.01]	2
11.1.1.	Threat Based P&MM Identification	3
11.1.2.	Creating and Comparing Scenarios	3
11.1.3.	Preliminary Evaluation and Decision Making.....	4
11.1.4.	Formal P&MM Reviews.....	4
11.2.	Third Party Damage [Protocol H.02]	4
11.3.	Pipelines Operating Below 30% SMYS [Protocol H.03].....	5
11.4.	Plastic Transmission Lines [Protocol H.04]	6
11.5.	Outside Force Damage [Protocol H.05]	6
11.6.	Corrosion [Protocol H.06].....	6
11.7.	Automatic Shutoff Valves or Remote Control Valves [Protocol H.07]	6

11.0. Introduction [192.935; Protocol Area H]

In accordance with 49 CFR 192.935, KMI evaluates and employs preventive and mitigative measures (P&MMs) to prevent and mitigate the consequences of a pipeline failure. The P&MM process consists of the following key components:

- Identification of P&MMs
- Evaluation of P&MMs
- Documentation
- Management of Change

As established in IMP Section 6, *Threat Identification, Data Integration, Risk Assessment*, KMI conducts threat identification and risk ranking. Upon having identified threats along a particular pipeline segment or facility, KMI evaluates the necessity of additional potential P&MMs.

11.0.1. Scope

This section describes the process for evaluating and selecting P&MMs for covered segments.

11.0.2. Responsibilities

The **Director of Risk Engineering** is responsible for the development, implementation, and oversight of the processes and procedures contained in this section. Additionally, the **Director of Risk Engineering** is responsible for the following specific components of this section:

- Oversight of P&MM evaluations
- Oversight of addition or modification of P&MMs

Risk Engineers are responsible for supporting the **Director of Risk Engineering** with the implementation of the policies and procedures contained in this section.

INTEGRITY MANAGEMENT PROGRAM

Engineering Records Department will maintain all completed P&MM projects and associated documentation for the life of the pipeline.

11.0.3. Associated KMI Procedures

The following KMI O&M Procedures are referenced in this section, and have been incorporated into this program:

- O&M Procedure 159, *Incident Reporting and Investigation*
- O&M Procedure 199, *Operator Qualification*
- O&M Procedure 215, *Patrolling and Leak Detection*
- O&M Procedure 232, *Damage Prevention and Public Education*
- Risk Process Document

11.1. General Requirements [192.935(a); Protocol H.01]

Identification and evaluation of additional P&MMs are based on identified threats to each pipeline segment and the risk analysis required by 49 CFR 192.917.

Initial P&MM evaluations for covered segments are scheduled based on the baseline assessment/reassessment plans published in March 2007. Evaluations for the top 50% (highest risk) covered segments will be completed by June 30, 2008. The remaining covered segments (lowest risk) will be evaluated by June 30, 2009.

Continual P&MM evaluations are completed for covered sections in response to the following events:

- Integrity assessment and subsequent remediation
- Significant leaks, failures, or incidents
- New information providing substantial changes to identified threats or relative risk ranking

In order to identify potential additional or new P&MMs, **Risk Engineering** conducts a P&MM evaluation process consisting of four critical steps:

- Threat based P&MM identification
- *PIRAMID*[™] - Scenario Comparisons
- Preliminary Evaluation and Decision Making
- Formal P&MM Reviews

The following sections establish the requirements and methodology for each of these steps.

11.1.1. Threat Based P&MM Identification [192.917; 192.935(a)]

Decisions regarding P&MMs are based on the threats identified during Risk Analysis Process (IMP Section 6, *Threat Identification, Data Integration, and Risk Assessment*). Specific pipeline threats are identified and P&MMs are evaluated by **Risk Engineering**.

In order to consistently and systematically identify P&MMs, **Risk Engineering** consults Table IMP 11-1, *Preventive and Mitigative Measures Selection Criteria*, for an initial identification of appropriate P&MMs for each unique threat. P&MM considerations include, but are not limited to:

- Enhancements to leak detection systems (e.g. Control Center monitoring)
- Addition of Automatic Shut-off Valves or Remote Control Valves
- Additional training for personnel on response procedures
- Enhancements to corrosion control efforts
- Enhancements to third party damage prevention programs
- Enhancements to inspections and maintenance programs

INTEGRITY MANAGEMENT PROGRAM

- Conduct drills with local emergency responders
- Replace pipe segments with segments of heavier wall thickness

Upon having identified threat based P&MMs, **Risk Engineering** employs *PIRAMID*[™] to further evaluate potential P&MM activities.

11.1.2. Creating and Comparing Scenarios [192.911(c); 192.935(a)]

Risk Engineering employs *PIRAMID*[™] to determine whether initially identified P&MM activities are appropriate (based on pipeline characteristics, operational parameters, integrity threat, initial risk, risk reduction, and benefit/cost). The *PIRAMID*[™] scenario creation function allows for creating "what-if" scenarios to determine the risk reduction due to an integrity activity. **Risk Engineering** employs *PIRAMID*[™] as a tool to evaluate the various risk control and mitigation methods by:

- Identifying risk control options that could lower the likelihood of a pipeline system incident, reduce the consequences, or both
- Systematically evaluating and comparing those options
- Selecting and implementing the optimum strategy for risk control

The existing attributes for the pipeline segment being modeled are stored as baseline data. *PIRAMID*[™] creates scenarios by modifying the attributes specific to the scenario while maintaining the remaining attributes in the baseline data as constant. Probability, consequence, and costs are calculated for the pipeline segment before and after scenario is implementation. The results can be compared to determine the impact of risk reduction and/or benefit cost due to the scenario.

Risk comparisons may be made based on cost/benefit ratio, total cost, utility, or impact index as a means to identify the most cost-effective approach to implementing P&MMs. For example, the P&MM scenario comparison can be employed to compare increased signage, increased patrols, and enhanced protection (against equipment damage) as an aid in selecting the most effective P&MM(s) to implement.

11.1.3. Preliminary Evaluation and Decision Making

Risk Engineers employ the *PIRAMID*[™] scenario comparison and risk evaluation functions for preliminary P&MM evaluations.

A spreadsheet consisting of output from the *PIRAMID*[™] model for initial system attributes (baseline) and potential P&MM scenarios is employed for preliminary screening. The spreadsheet contains the total combined impact, and the risk before and after the P&MM scenario.

Risk Engineers perform a preliminary evaluation of the P&MM scenario results and eliminate any P&MM scenario that does not result in any risk reduction or provides no benefit/cost. The resulting P&MM scenario comparison list is employed in the formal review process, and documented on ICAM software.

11.1.4. Formal P&MM Reviews

Upon having completed threat based P&MM identification, scenario modeling, and preliminary evaluation of P&MMs, **Risk Engineering** presents the proposed P&MMs to other KMI personnel. Formal P&MM reviews may combine several covered segments with similar characteristics in a single discussion. Representatives from **Engineering, Operations** (district managers, maintenance, and corrosion staff, etc.), and **Business** departments are present for the formal P&MM reviews to finalize the selection of P&MMs. As with each component of the P&MM process, review results are documented on ICAM.

INTEGRITY MANAGEMENT PROGRAM

Approved final P&MMs are budgeted for and tracked until completion by the *Director of Risk Engineering*.

11.2. Third Party Damage [192.935(b)(1); Protocol H.02]

In supplement to the Damage Prevention Program and in accordance with 49 CFR 192.935 (b), KMI has developed enhanced measures to prevent third party damage. These enhanced measures include the following:

- Using qualified personnel for IMP work tasks such as marking, locating, and direct supervision of direct excavation work
- Collection, in a central data base, location specific information on excavation damage (covered and non-covered segments) and root cause analysis
- Participation in one-call systems
- Monitoring of excavations on covered segments by KMI personnel

In the event that third party damage is identified as a threat, KMI, at a minimum, enhances its damage prevention program with the listed actions below to prevent and minimize the consequences of a release due to third party damage:

- Using qualified personnel for work conducted by KMI (O&M Procedure 199, *Operator Qualification*)
- Collecting and recording information in STARS™ central database on excavation damage that occurs on covered and non-covered segments in the transmission system. It will include root cause analysis to support identifying targeted additional preventive and mitigative measures in HCA's. The report will include recognized damage that is not required to be reported to DOT as an incident (O&M Procedure 159, *Incident Reporting and Investigation*).
- Participating in one-call systems in locations with covered segments (O&M Procedure 232, *Damage Prevention and Public Education*)
- Providing pipeline personnel to monitor excavations conducted on covered pipeline segments (O&M Procedure 215, *Patrolling and Leak Detection*)

11.3. Pipelines Operating Below 30% SMYS [192.935(d); Protocol H.03]

For pipelines operating below 30% SMYS and located in an HCA, KMI implements the following actions:

- Use qualified personnel for work conducted by KMI (O&M Procedure 199, *Operator Qualification*)
- Participate in one-call systems in locations with covered segments (O&M Procedure 232, *Damage Prevention and Public Education*)
- Monitor excavations near the pipeline or conduct bi-monthly pipeline patrols. If an indication of an unreported construction activity is discovered, a follow-up investigation will be required to determine if mechanical damage has occurred. (O&M Procedure 215, *Patrolling and Leak Detection*) For pipelines operating below 30% SMYS and located in a Class 3 or 4 area but not in an HCA, KMI will implement the following actions:
- Use qualified personnel for work conducted by KMI (O&M Procedure 199, *Operator Qualification*)
- Participate in one-call systems in locations with covered segments (O&M Procedure 232, *Damage Prevention and Public Education*)
- Monitor excavations near the pipeline or conduct bi-monthly pipeline patrols. In the event that an indication of an unreported construction activity is discovered, a follow-up investigation will be required to determine if mechanical damage has occurred. Perform semi-annual leak surveys or quarterly leak surveys for unprotected pipe or cathodically

INTEGRITY MANAGEMENT PROGRAM

protected pipe where electrical surveys are impractical (O&M Procedure 215, *Patrolling and Leak Detection*).

Guidance for selecting P&MMs related to these two conditions listed above is attached as Table IMP 11-2, *Preventive and Mitigative Measures for Pipelines Operating at less than 30% SMYS in an HCA*, and Table IMP 11-3, *Preventive and Mitigative Measures for Pipelines operating Below 30% SMYS in a Class 3 or 4 but not in an HCA*.

11.4. Plastic Transmission Lines [192.935(e); Protocol H.04]

In the event that KMI operates a plastic transmission pipeline in a covered segment, KMI will consider the following P&MMs:

- Use qualified personnel for work conducted by KMI (O&M Procedure 199, *Operator Qualification*)
- Participate in one-call systems in locations with covered segments (O&M Procedure 232, *Damage Prevention and Public Education*)
- Provide pipeline personnel to monitor excavations conducted on covered pipeline segments (O&M Procedure 215, *Patrolling and Leak Detection*)

11.5. Outside Force Damage [192.935(b)(2); Protocol H.05]

In the event that KMI determines damage by outside forces (earth movements, floods, unstable suspension bridge) is a threat, KMI may implement measures to minimize the consequences from the outside force threat (O&M Procedure 215, *Patrolling and Leak Detection*). Additional measures to minimize the consequences of damage from outside forces include, but are not limited to:

- Increasing patrol frequency
- Increased signage
- Adding external protection
- Reducing external stress
- Relocating the line

11.6. Corrosion [192.917(e)(5); Protocol H.06]

As with other threats, KMI takes measures to determine if corrosion is a threat to covered pipeline segments. In the event that a corrosion threat is identified, KMI completes:

- Evaluation and remediation of covered and non-covered segments with similar material coating
- Development of a schedule for evaluating and remediation, as necessary, the similar segments consistent with the operator's established operating and maintenance procedures under 49 CFR 192 for test and repair.

11.7. Automatic Shutoff Valves or Remote Control Valves [192.935(c); Protocol H.07]

Risk Engineering conducts a risk and cost benefit analysis to determine whether an automatic shutoff valve (ASV) or remote control valve (RCV) would be an efficient means of adding protection to an HCA in the event of a gas release. The review includes, at a minimum: leak detection speed, pipe shutdown capabilities, the type of gas transported, operating pressure, rate of potential release, pipeline profile, potential for ignition, and nearest response personnel location. **Risk Engineering**, with the assistance of **System Design**, evaluates the installation feasibility.

INTEGRITY MANAGEMENT PROGRAM

Table IMP 11-1 – Preventive and Mitigative Measures Selection Criteria

See attached table.

INTEGRITY MANAGEMENT PROGRAM

**Table IMP 11-2 - Preventive and Mitigative Measures
 Pipelines Operating at less than 30% SMYS in an HCA
 [Part 192, Table E.11.3]**

Threat	Existing 192 Requirements		Additional Preventive & Mitigative Measures to 192 requirements
	Primary	Secondary	
External Corrosion	455-(Gen. Post 1971) 457-(Gen. Pre-1971) 459-(Examination) 461-(Ext. coating) 463-(CP) 465-(Monitoring) 467-(Elect Isolation) 469-(Test Stations) 471-(Test Leads) 473-(Interference) 479-(Atmospheric) 481-(Atmospheric) 485-(Remedial) 705-(Patrol) 706-(Leak survey) 711-(Repair – gen.) 717-(Repair – perm.)	603-(Gen Oper) 613-(Surveillance)	<p><u>For Cathodically Protected Trans. Pipelines</u></p> <ul style="list-style-type: none"> • Perform an electrical survey (i.e. indirect examination tool/method) at least every 7 years. Results are to be utilized as part of an overall evaluation of the CP system and corrosion threat for the covered segment. Evaluation shall include consideration of leak repair and inspection records, corrosion monitoring records, exposed pipe inspection records, and the pipeline environment. <p><u>For Unprotected Trans. Pipelines or for Cathodically Protected Pipe where Electrical Surveys are Impracticable</u></p> <ul style="list-style-type: none"> • Conduct quarterly leak surveys AND • Every 1-1/2 years, determine areas of active corrosion by evaluation of leak repair and inspection records, corrosion monitoring records, exposed pipe inspection records, and the pipeline environment
Internal Corrosion	475-(Gen IC) 477-(IC Monitoring) 485-(Remedial) 705-(Patrol) 706-(Leak Survey) 711 (Repair – gen.) 717-(Repair – perm.)	53(a)-(Materials) 603-(Gen Oper) 613-(Surveillance)	<ul style="list-style-type: none"> • Obtain and review gas analysis data each calendar year for corrosive agents from transmission pipelines in HCA's, • Periodic testing of fluid removed from pipelines. Specifically, once each calendar year from each storage field that may affect transmission pipelines in HCA's, AND • At least every 7 years, integrate data obtained with applicable internal corrosion leak records, incident reports, safety related condition reports, repair records, patrol records, exposed pipe reports, and test records.
3rd Party Damage	103-(Gen. Design) 111-(Design Factor) 317-(Hazard Protection) 327-(Cover) 614-(Dam. Prevent) 616-(Public Education) 705-(Patrol) 707-(Line Markers) 711 (Repair – gen.) 717-(Repair – perm.)	615 –(Emergency Plan)	<ul style="list-style-type: none"> • Participation in state one-call system, • Use of qualified operator employees and contractors to perform marking and locating of buried structures and in direct supervision of excavation work, AND • Either monitoring of excavations near operator's transmission pipelines, or bi-monthly patrol of transmission pipelines in HCA's or Class 3 and 4 locations. Any indications of unreported construction activity require a follow-up investigation to determine if mechanical damage occurred.

INTEGRITY MANAGEMENT PROGRAM

**Table IMP 11-3 - Preventive and Mitigative Measures
 Pipelines operating Below 30% SMYS in a Class 3 or 4 but not in an HCA
 [Part 192, Table E.II.1]**

Threat	Existing 192 Requirements		Additional Preventive & Mitigative Measures to 192 requirements
	Primary	Secondary	
External Corrosion	455-(Gen. Post 1971) 457-(Gen. Pre-1971) 459-(Examination) 461-(Ext. Coating) 463-(CP) 465-(Monitoring) 467-(Elect Isolation) 469-(Test Stations) 471-(Test Leads) 473-(Interference) 479-(Atmospheric) 481-(Atmospheric) 485-(Remedial) 705-(Patrol) 706-(Leak Survey) 711-(Repair-gen.) 717-(Repair-perm.)	603-(Gen Oper) 613-(Surveillance)	For Cathodically Protected Transmission Pipeline: <ul style="list-style-type: none"> • Perform semi-annual leak surveys. <p>-----</p> For Unprotected Transmission Pipelines or for Cathodically Protected Pipe where Electrical Surveys are Impractical: <ul style="list-style-type: none"> • Perform quarterly leak surveys
Internal Corrosion	475-(Gen IC) 477-(IC Monitoring) 485-(Remedial) 705-(Patrol) 706-(Leak Survey) 711 (Repair-gen.) 717-(Repair-perm.)	53(a)-(Materials) 603-(Gen Oper'n) 613-(Surveillance)	<ul style="list-style-type: none"> • Perform semi-annual leak surveys.
3rd Party Damage	103-(Gen. Design) 111-(Design Factor) 317-(Hazard Protection) 327-(Cover) 614-(Dam. Prevent) 616-(Public Education) 705-(Patrol), 707-(Line Markers) 711 (Repair – gen.) 717-(Repair – perm.)	615-(Emergency Plan)	<ul style="list-style-type: none"> • Participation in state one-call system, • Use of qualified operator employees and contractors to perform marking and locating of buried structures and in direct supervision of excavation work, AND • Either monitoring of excavations near operator's transmission pipelines, or bi-monthly patrol of transmission pipelines in Class 3 and 4 locations. Any indications of unreported construction activity require a follow-up investigation to determine if mechanical damage occurred.

7. Preventive and Mitigative Measures

Preventive and Mitigative Measures (P&MM's) are activities to be considered that are intended to provide additional protection to the High Consequence Areas. The P&MM's are required to be evaluated by the user after the threats have been identified. A P&MM Selection Criteria checklist provides a list of activities to be considered and identifies which threat the activity applies. P&MM activities will be evaluated using scenarios created in PIRAMID™. The results of the scenarios will be evaluated against implementation criteria and subject to further SME review. This section will describe the evaluation process.

7.1. Identify threats through PIRAMID™

The final BAP (See Section 4) will identify the threats associated with each HCA segment. These threats will be used as a starting point for determining which activity to consider for evaluation.

7.2. P&MM selection criteria checklist

7.2.1. Locate the P&MM tab on the PIPER output sheet from the BAP. Each HCA will be listed along the left side axis and the P&MM activities to consider for evaluation will be across the top. For each row of each HCA, there will be series of "X's". These "X's" correspond to the associated P&MM activity along the top of the sheet. A scenario will be evaluated in PIRAMID for each "X" associated with the HCA segment.

7.3. Evaluate P&MM's through PIRAMID™

The P&MM activities will be evaluated through scenarios created in PIRAMID™.

7.3.1. Scenario Creation in PIRAMID™¹

7.3.1.1. Scenarios allow the user to update attributes associated with a mitigative activity to determine the impact of the change. A filter in the scenario is used to show the user which attributes may be updated with new data. As an example – If the user chooses the scenario "increase signage", the attributes the user can change associated with that scenario will be displayed. The filter can be turned off which will display all the attributes.

7.3.1.2. Scenarios have been created in PIRAMID™ as a template to address the P&MM activities on the Checklist.

7.3.2. Merge or Import ".pir" file

The data is downloaded into PIRAMID™ by using either the Merge or Import command.

7.3.2.1. Merge data

7.3.2.1.1. Open PIRAMID™ and load the template. The template is located in folder :All_Engr\Risk Engineering\Risk Ranking\Templates\P&MM_scenarios_template.pir

7.3.2.1.2. Click on the "Merge" command under 'File' in the toolbar to open a new window. (See figure 7.1). Before "Merging", the user is cautioned that the Probability Modules in the template ".pir" file and the ".pir" file that will be merged must be the same. If different, the user should remove the probability modules in the template that do not match the modules in the ".pir" to be merged. After merging, the user can add the probability modules back to the template.²

¹ See PIRAMID™ Users Guide 5.8.4 for more information on creating scenarios. The user is expected to understand the basic operation of PIRAMID™.

² See PIRAMID users guide Section 5.7.1 and 5.7.2 for more information on "Adding" modules.

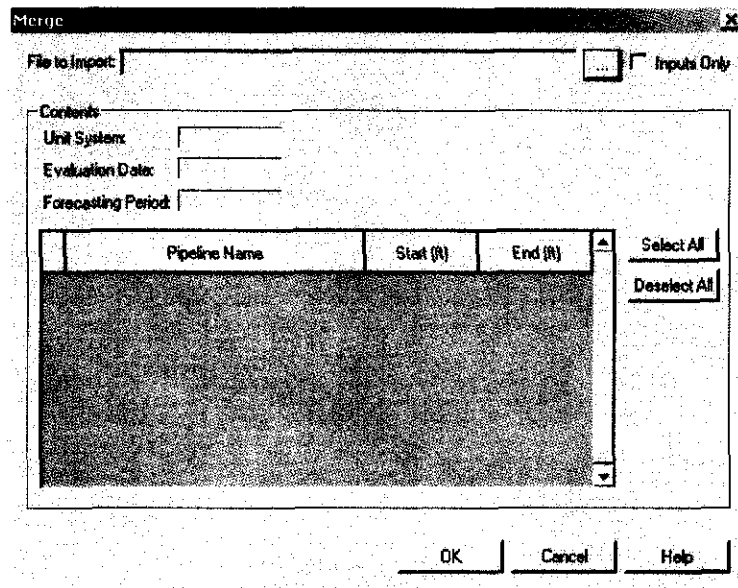



Figure 7.1. Merge window

- 7.3.2.1.3. Click on the three dot icon, , to the right of the "File to Import" line to open a new window labeled "Import database". The user will need to locate the ".pir" file that contains the completed PIRAMID™ analysis for the HCA segment to be evaluated. When located, highlight the file name and click "Import". The .pir file name will now be listed in the 'File to Import' line, the Contents windows will display data and the segments in the ".pir" file will be displayed.
- 7.3.2.1.4. Check the box next to the "Inputs Only" entry. Check the box(es) next to the pipeline segments the user would like to merge. The user can click on "Select All" to choose every HCA segment to merge.
- 7.3.2.1.5. When segments have been chosen, click on "OK" to merge the data into the template. The data should merge and each segment should be listed under the System folder and under each scenario.
- 7.3.2.1.6. When the data has been merged, the user can delete the segment named "Test" under the "System" folder. It is not needed after the data has been merged.
- 7.3.2.1.7. Save the changes by Clicking on "File" in the main toolbar and click "Save As". Change the name of the .pir file to the appropriate name and save it in an appropriate folder on the Risk Engineering drive.
- 7.3.2.1.8. The user can repeat steps 7.3.2.1.2 to 7.3.2.1.6 to merge data from another ".pir" file into the template. Save the file after merging the data.

7.3.2.2. Import .pir file data

As an alternative, the user can import the data from a .pir file that has already been calculated.

- 7.3.2.2.1. Open PIRAMID™ and load the template. The template is located in folder: All_Engr\Risk Engineering\Risk Ranking\Templates\P&MM_scenarios_template.pir

- 7.3.2.2.2. Click on the "Import" command under "File" in the toolbar to open a new window. (See Figure 7.2)

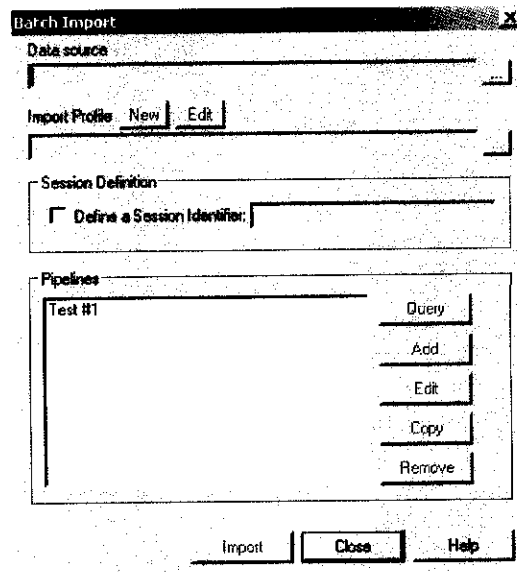


Figure 7.2 – Batch Import window

- 7.3.2.2.3. In the Batch Import window under "Data Source", the user will select "MS Access Database" located under the Machine Data Source tab. See Figure 7.3

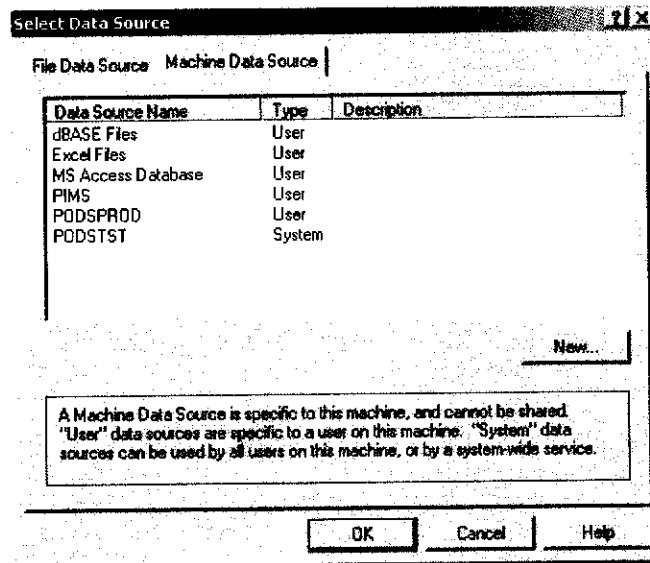


Figure 7.3 – Machine Data Source tab

- 7.3.2.2.4. Click on "OK" to open a window called "Select Database file". The user will click on "All files" under "List Files of Type:" and locate the .pir file containing the segments of interest.
- 7.3.2.2.5. Highlight the .pir file (it will be displayed in the Database Name window in the upper left corner of the active window) and click "OK".
- 7.3.2.2.6. Under Import profile, the user will need to load the profile that allows the .pir data to be imported. The file is named "PIRAMID.pdp" and is located in the folder All_Eng\RiskEngineering\RiskRanking\Profile\PIRAMID.pdp

- 7.3.2.2.7. After the profile is loaded, hit "Query" and another window opens named "Query Pipelines". Click OK and the segments from the .pir file will be loaded and be displayed into the lower left window. Highlight the segments to be imported and click the "Import" button. Answer "Yes" to merge with existing data.
- 7.3.2.2.8. Click on Close to import the data into the active .pir file.
- 7.3.2.2.9. When the data has been imported, the user can delete the segment named "Test" under the "System" folder. It is not needed after the data has been imported.
- 7.3.2.2.10. Save the changes by Clicking on "File" in the main toolbar and click "Save As". Change the name of the .pir file to the appropriate name and save it in an appropriate folder on the Risk Engineering drive.
- 7.3.2.2.11. The user can repeat steps 7.3.2.2.2 to 7.3.2.2.8 to import data from another '.pir' file into the template. Save the file after importing the data.

7.3.3. Modify Attributes in Scenario and Evaluation

- 7.3.3.1. Click on the "+" sign next to the System folder to expand and display the segments that were merged or imported from the previous step. Click on the "+" sign next to the Segments folder to expand it. An "italicized" segment will indicate an HCA designated segment exists in the pipeline segment. If no segment appears "italicized", verify an HCA area exists.³ Each folder listed under the "System" should be color coded blue. If a folder color is yellow, there is data in an attribute(s) that is needed. The user should fill in the missing data by opening the ".pir" file that was used to merge and use that data for updating the segment attribute that was missing.
- 7.3.3.2. Click on the "Products" folder on any of the segments that was merged or imported. Check the box labeled "Apply to Multiple Pipelines". Click on "OK" and then click on "Select All" in the next window. All of the segments should then be checked. Click "OK" to apply.
- 7.3.3.3. Click on the "+" sign next to the Scenario folder to expand and display each of the scenarios to be evaluated. Clicking on the "+" sign next to each scenario will further expand the folder to display each segment listed under the system folder.
- 7.3.3.4. Using the output from the PIPER spreadsheet from Section 7.2.1, locate the first segment in the System folder on the PIPER spreadsheet. Identify each scenario to be evaluated by noting the activity in the column header for each "X" in the row for that segment. Multiple scenarios for each segment may be present.
- 7.3.3.5. In PIRAMID™, open a scenario to be evaluated by double clicking on the scenario folder. A new window named "Scenario Properties" will open with the scenario name in the Name window. Highlight "Modify Attributes Action1" in the Action window to activate the choices Add, Edit, Copy or Remove. Click on the Edit button to modify attributes. See Figure 7.4.

³ Open the attributes folder and go the HCA attributes. Check if any rechain segment is listed as "Yes" in the "HCA – PIC with 20+ SIHO" attribute or there is an entry in the "HCA – PIC with identified site" attribute other than "No". If there is an HCA, then the segment needs to be re-segmented. Re-segment if needed. If no, then no HCA exists on that segment and no evaluation will be required.

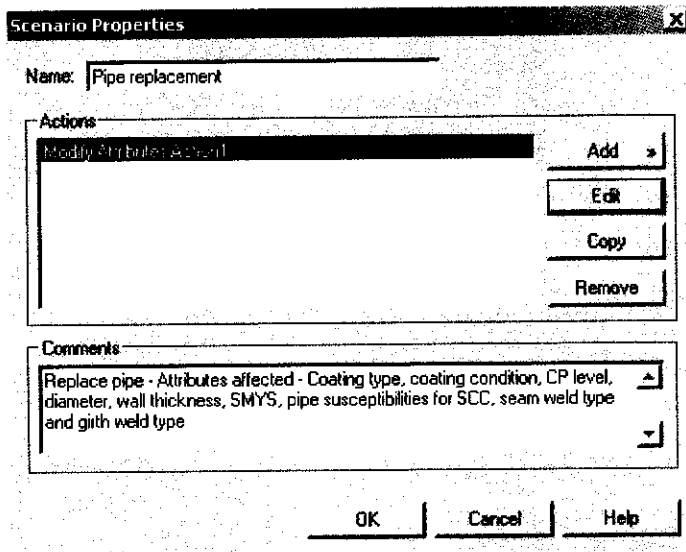


Figure 7.4 - Scenario Properties

7.3.3.6. A new window named Modify Line Attributes will open. (See Figure 7.5) Pipe replacement will be used as an example. In this window, the user will modify each segment in the left hand window that lists pipe replacement as a mitigative measure from the PIPER spreadsheet. Using the filter on the top right, attributes associated with pipe replacement will be shown. All other attributes still remain but are filtered out or hidden. Modifications are made to the attribute(s), however, not every attribute needs to be modified. (As an example – If the pipe being replaced is the same diameter, that attribute does not need to be modified.) When an attribute has been modified, a red “*” appears next to the attribute in the right window. Once modifications are completed for the attributes on the pipe segment folder, the user can click on the next segment requiring a pipe replacement action. An initial cost for implementing the scenarios will need to be entered under “Initial Cost (\$1000’s)”. A red checkmark will appear when changes have been made to a folder. Be aware that if the user has imported many segments into the “.pir” file, pipe replacement may not apply to every one of them.

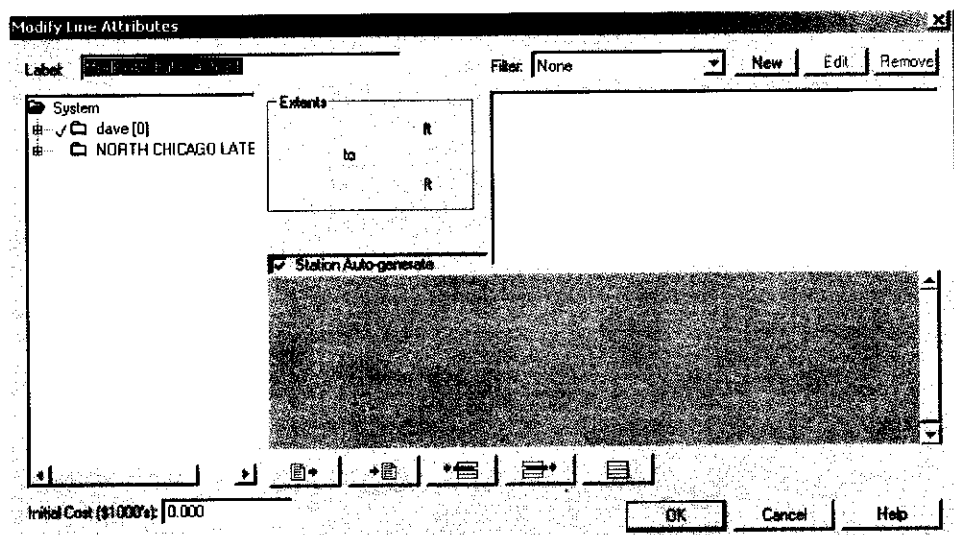


Figure 7.5 - Modify Line Attributes

- 7.3.3.7. Click on the "+" sign to the left of the line segment to be modified under the System folder. This will expand the line to display each segment including the "italicized" HCA's. Click to highlight the italicized segment. All the attributes will be displayed for that segment in the right window with pipeline information and current attribute value in the large window below "Station Auto-generate".
- 7.3.3.8. Click on the "down" arrow next to "None" in the Filter window. Highlight "pipe replacement" from the drop down window. This will display the attributes associated with a pipe replacement.
- 7.3.3.9. The user will be required to have the new attribute values prior to running the scenarios. These values can be obtained from Project Management, Operations or SME's. As an example – if the current pipe has a wall thickness of 0.280 in and a SMYS of 52K – the replacement pipe might be 0.325 in and 60K.
- 7.3.3.10. Click on each attribute in the top right window and make the pipe replacement modifications in the lower window by changing the attribute value. Some modifications may also require changes to the rechain numbers as well. Clicking on the down arrow next to an attribute in the lower window will open a drop down with attribute choices. Choose a new attribute if allowed from the drop down or enter the modification manually.
- 7.3.3.11. When all attribute modifications have been made to the current line segment, the user can select the next line segment in the left window to modify.
- 7.3.3.12. Repeat step 7.3.3.10 for each new segment for that particular activity.
- 7.3.3.13. The initial cost is the sum of each individual segment that was modified in the scenario. The unit costs must be the same for each diameter of pipe. As an example, for pipe replacement in 3 separate segments for 30" pipe, the cost for each segment should be the same cost per mile. If the segments are 1000', 2000' and 3000', and the unit cost is \$500/foot, the initial cost sum is \$3MM and 3000 will be entered in as the initial cost. If the unit costs are not the same, a new scenario will need to be created for those segments that are subject to a different unit cost.
- 7.3.3.14. When all the modifications have been made to the first scenario, Click on the "OK" button to close it and Click "OK" again. A "Scenario Update" screen will appear to show the progress.
- 7.3.3.15. After each scenario has been selected and the modifications have been made, the user will Click on "Calculate" in the main toolbar and Click on "All" from the drop down menu. As PIRAMID™ calculates the data; a window will appear and display the progress of the calculation.
- 7.3.3.16. After the calculation is complete, all folders that have been modified will turn blue. Save the changes by Clicking on "File" in the main toolbar and click "Save".

7.3.4. Evaluate PIRAMID™ data

The Segment and Decision Analysis functions in PIRAMID™ are used to evaluate the scenarios for further review by the SME's and possible implementation.

- 7.3.4.1. Open the Evaluation menu on the top toolbar and click on "Options" from the drop down menu. There are two tabs. On the Risk display tab, verify the Component Risk Units and Segment Risk Units in per segment-yr are checked. Modify if needed. See Figure 7.6.

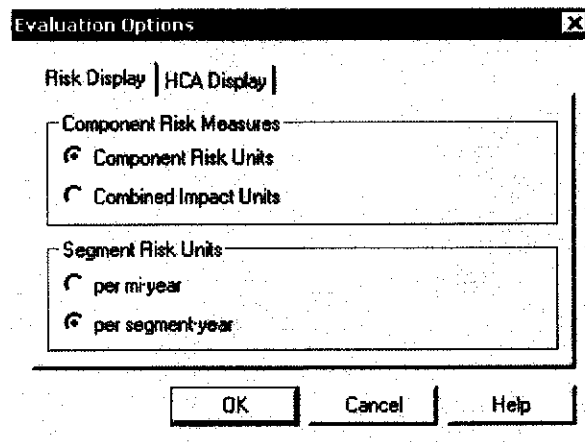


Figure 7.6 – Evaluation Options – Risk Display

- 7.3.4.2. Click on the HCA Display tab and check "Show HCA segments only". Click "OK" to save the changes.

7.3.5. Segment Analysis

- 7.3.5.1. Open the Evaluation menu on the top toolbar; highlight Segment Analysis and then "Define". Check the box to the left of PIRAMID™. Checkmarks will appear in all the remaining boxes. The user also has the option to check each box individually.
- 7.3.5.2. Click on "OK" to start the segment analysis. A window will open showing the progress of the analysis. When the calculation is complete, a new window will open named "Define Segment Analysis. See Figure 7.7 below.

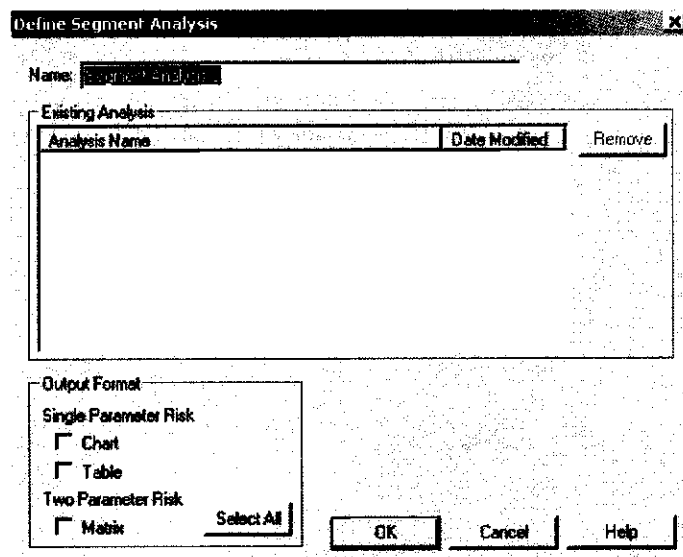
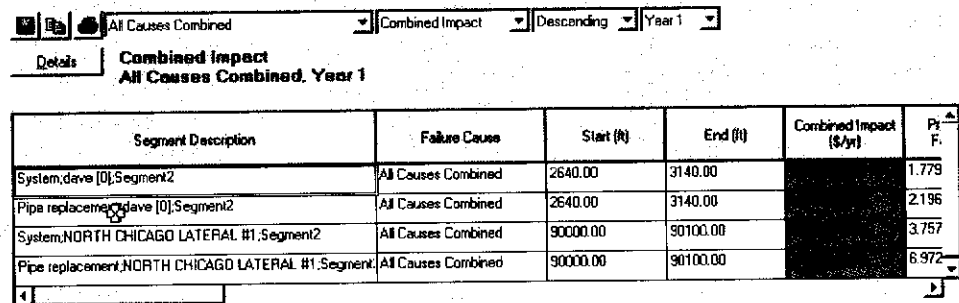


Figure 7.7 – Define Segment Analysis window

- 7.3.5.3. The user should change the name of the output to indicate what was calculated. (As an example – Scenarios for all GC #1 HCAs.) Check the box next to "Table" under the Output Format. Click OK to calculate. The output from this analysis is used to evaluate risk reduction.

7.3.6. Saving PIRAMID™ Segment Analysis output

- 7.3.6.1. Using the left mouse button, highlight the cells labeled under the headers *Segment Description*, *Failure Cause*, *Start*, *End* and *Combined Impact* (See Figure 7.8 below). Click on the icon labeled "📄" to copy the data.



Details **Combined Impact**
All Causes Combined, Year 1

Segment Description	Failure Cause	Start (\$)	End (\$)	Combined Impact (\$/yr)	P/F
System,dave [0].Segment2	All Causes Combined	2640.00	3140.00		1.779
Pipe replacement,dave [0].Segment2	All Causes Combined	2640.00	3140.00		2.196
System,NORTH CHICAGO LATERAL #1.Segment2	All Causes Combined	90000.00	90100.00		3.757
Pipe replacement,NORTH CHICAGO LATERAL #1.Segment	All Causes Combined	90000.00	90100.00		6.972

Figure 7.8 – PIRAMID™ Segment Analysis Output

- 7.3.6.2. Paste the data into the Scenario Segment Analysis spreadsheet. The spreadsheet is located in the folder All_Engr\RiskEngineering\Risk Ranking\Post Pyramid/Segment Analysis_Scenarios. The user will need to append to the spreadsheet as data is added from the evaluation of additional scenarios. The spreadsheet will contain a macro that calculates the risk reduction for each activity that was chosen. The risk reduction percentage and the total combined impact cost will be used for evaluating the P&MM activity.

7.3.7. Calculate Benefit-Cost ratio

- 7.3.7.1. Open the Evaluation menu on the top toolbar; highlight Decision Analysis and then "Define". A new window will open that lists the Available Segments and Scenarios to Analyze. (See figure 7.9.)

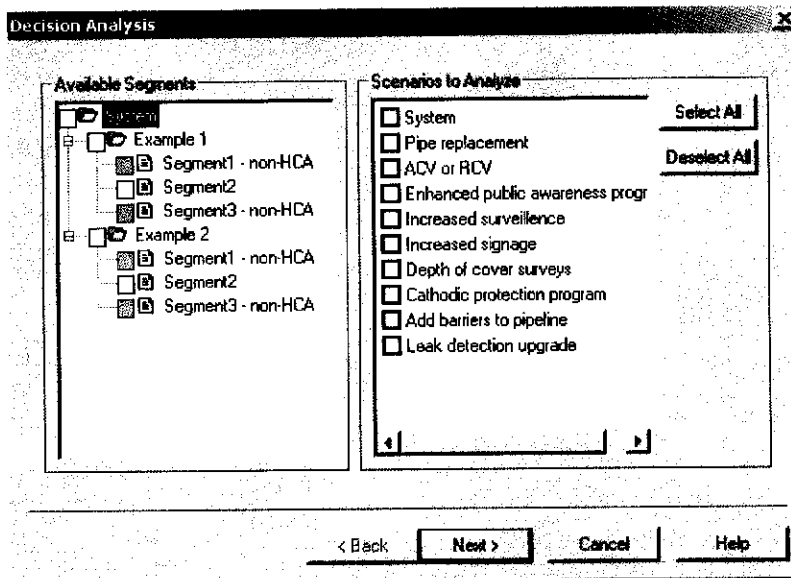


Figure 7.9 - Decision Analysis Window


- 7.3.7.2. Check the box to the left of System under the Available Segments window. Checkmarks will appear in the boxes next to the segments to be analyzed.
- 7.3.7.3. Check each box to the left of "System" and each scenario under the Scenarios to Analyze window. Click "Next".
- 7.3.7.4. Check the circle next to Benefit-cost ratio and then click on the "Add" button. The Benefit-cost ratios will appear in the "Selected Options" window. Click on "Finish" and PIRAMID™ will calculate the benefit-cost ratios and show the progress of the calculation.
- 7.3.7.5. A new window will open and the user can change the name of the output to indicate what was calculated. Check the box next to "Table" under the Output Format. Click OK to calculate. A window will open that displays the calculated results. (See Figure 7.10 below). The output from this analysis is used to evaluate the benefit cost.

Selected Scenarios... Benefit-cost ratio (safety constraint)

Benefit-cost Ratio (safety constraint)
Pipe replacement

Scenario	Time (years)	Impact reduction per unit maintenance cost
Pipe replacement	1	1.2964e-002
Pipe replacement	2	2.5894e-002
Pipe replacement	3	3.8778e-002
Pipe replacement	4	5.1604e-002
Pipe replacement	5	6.4365e-002
Pipe replacement	6	7.7051e-002
Pipe replacement	7	8.9654e-002

Figure 7.10 – PIRAMID™ Benefit Cost output

7.3.7.6. Using the left mouse button, highlight the cells labeled under the headers Scenario, Time and Impact Reduction per unit maintenance cost. Click on the icon labeled "" to copy the data.

7.3.7.7. Paste the data into the second tab of the Scenario Segment Analysis spreadsheet. The spreadsheet is located in the folder All_Engr\Risk Engineering\Risk Ranking\Post Pyramid/Segment Analysis_Scenarios. The user will need to append to the spreadsheet as data is added from the evaluation of additional scenarios. The spreadsheet will contain a macro that calculates whether the benefit cost is greater than or equal to 1. It will also show the year(s) where the benefit/cost meets that criterion. The benefit/cost will be used for evaluating the P&MM activity.

7.4. Evaluation of P&MM activities using PIRAMID™ output.

The total combined impact cost in \$/year and the benefit/cost ratio outputs from PIRAMID™ are the criteria to be used for scenario evaluation. The total combined impact cost is used to calculate a reduction in risk. Percentage in risk reduction is calculated by determining the difference between the total combined impact cost for the system and the scenario. The initial criterion to be used is benefit/cost to develop the list for review by the SME's.

7.4.1. Benefit/Cost Criteria

7.4.1.1. The benefit/cost must be greater than or equal to 1 (≥ 1). If the ratio is less than 1, the cost to implement the activity exceeds the benefit and will not be considered. The risk reduction percentages and the total combined impact costs for those activities meeting the benefit/cost criteria will be identified in the evaluation spreadsheet. This spreadsheet will be used for review with the field operations personnel and the SME's.

7.5. Subject Matter Expert (SME) review of viable P&MMs

7.5.1. The risk engineer will meet with the SME's to discuss the results of the P&MM evaluation. The list of HCA segments along with their associated P&MM(s) will be used. SMEs will review and confirm the measures currently being performed for each threat on a line by line basis.

7.5.2. The results of the SME review meeting to discuss the implementation of each specific P&MM will be documented. A documented reason for not implementing a specific P&MM activity will also be provided.

7.6. Implement P&MMs

7.6.1. The finalized list of HCA segments along with their associated P&MM(s) evaluated by the SME's will be used for budgeting purposes.

Appendix B