PAnORaMA+

Piping **A**nalysis, **O**perations **R**esearch **A**nd **M**aintenance **A**pplication

A SUPERIOR SOFTWARE :

- For Accurate Pipe Leak Detection
- Capable of handling Multi Products
- A Training Simulator
- SCADA System
- With Commercial Support
- Operation Friendly and Cost effective

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Procurement of PAnORaMA or PAnORaMA Services

Basic PAnORaMA comprises of modules 1-4 described above. It offers the user network simulation power. Modules 5-10 can be procured depending on the requirement. Any add-on support (#11) will be on developmental manpower basis.

The purchase will have to be for PAnORaMA for gas distribution, liquid distribution or both.

The software is available on 'seat' basis where user purchases one or more copies implemented at client's computing facility. The software is also available on 'rental' basis for limited period. The software can also be made available on 'services' basis where the client outsources the knowledge processes and PAnORaMA team provides on-site or remote services. PAnORaMA team is open to any other model.

The buy comes with a comprehensive training on domain concepts, software usage and backup.

All pricing is based on the network complexity and is computed on the basis of number of nodes in a network and total length of the pipe segments.

For parties new to the crosscountry business, this pricing philosophy affords a great opportunity as for initial simple network, PnORaMA would come at a very reasonable price.

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The simulation also allows analysis of water hammer effects and pressure surges etc. in case of sudden closure of valve, tripping of pumps, pump start up etc. It can be used to size air chambers, study optimal locations of air relief valves, size suck past lines and pump bypass lines for pumps etc. to mitigate pressure surges detrimental to the health of the pipeline.

Simulation is an excellent design aid for a proposed pipeline network as well as an excellent decision making aid for an existing pipe network.

Simulations can support entire gamut of decision making for a proposed/existing pipeline project.

5. Emulation Engine:

This is a simulation with user introduced faults in specific segments, instruments such as flow and pressure recorders as well as in the network. For example, user may add some percentage error in the specific lengths of specific segments so that additional resistance to flow could be created. A segment diameter could be modified with some error in diameter which allows to capture the effects of scaling or condensate collection in a segment. User could alter the surface roughness of a pipe segment to create the effect of corrosion/erosion on pipe hydraulics. Overall, the pipe characteristics could be changed. Similarly, for pressure and/or flow measurement instruments at a node, least count of the instrument could be defined, bias could be added to the reading or a random error could be introduced in the measurement. The simulation results are altered incorporating these faults and instrument limitations. Similarly, a leakage of any magnitude could be created at any location on any segment. The simulation modified with these real life like faults serves as an emulator or a virtual pipe network. This is very useful for operator training.

Comparison of simulation and emulation results, with emulation set up with known limitations of instruments and faults allows appreciation of sensitivity of various pipeline operation related parameters to various system faults. The simulation -emulation combine can give a feel of pipeline operation like nothing else.

6. Operator Trainer:

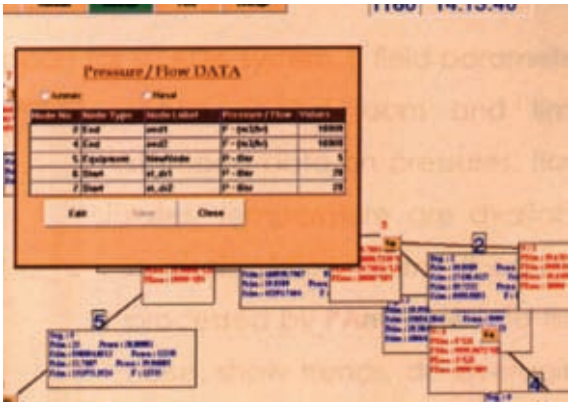
The simulation/emulation combine has been implemented with a server-client architecture. An instructor can use emulator on one server as virtual pipeline network. The operators can operate a part or whole of the network as per privileges granted. For example, the operator can change control valve set points, equipment operation etc. to respond to the performance of a virtual network set-up by the instructor. Instructor can watch operator response live as well as in postmortem mode to effectively train operators to handle all kinds of eventualities.

Several operator nodes can be set up, each on a separate PC in the network, a comprehensive security manager can be used to decide each operator's privileges, operator can transfer their privileges to another operator etc.

Simulation results are also available along with emulation results to provide simulation-based guidance to the operator.

The operator training module is a training aid even better than on-job training, because situations which may not even occur in real life, or occur very infrequently, can be created by the trainer on the pipeline emulator. Operator response and reflexes to all situations can thus be honed appropriately.

Real control room like 'look and feel' can be created with consoles as they would be when the pipeline is commissioned and is under SCADA supervision.



This includes hi-lo alarms on pressures, flowrates etc., trends, historians, leak detection, instrument fault detection, pigging advice, shrinkage calculations, generation of bills, calculation of penalties based on GTA (Gas Transmission Agreements) etc.

PAnORaMA based training simulator is a must for any pipeline operator. The simulator is rigorous, and not the trend simulator often used in training simulators. The same simulator can then be used for decision making with actual network operation. Only the emulation is replaced by actual data signals from actual pipeline. The trainee thus seamlessly transforms to a competent operator without any cultural shock.

7. Network Commerce:

PAnORaMA supports shrinkage calculations for the network dynamically. The pressure time series at all nodes is used to calculate network shrinkage at every polling instance. The integration of this shrinkage time-series generates shrinkage over an hour, day, month etc.

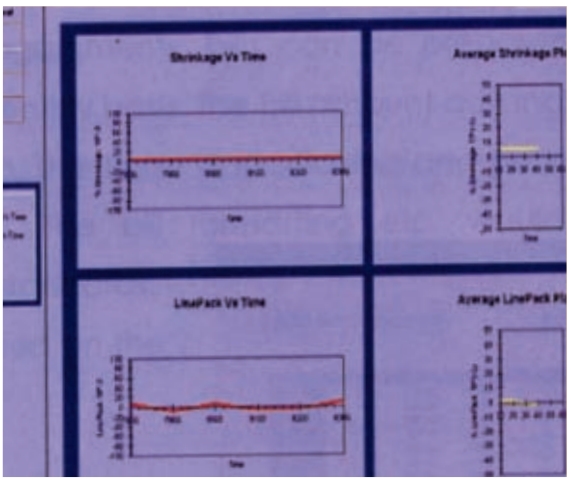
The line pack calculation is critical to shrinkage calculation. In PAnORaMA, the same is based on actual pressure profile along each pipe section. Conventional calculations assume linear pressure profile along a segment. This is an inadequate assumption for networks under sever transients. PAnORaMA simulation generates a more granular pressure profile because it needs to further discretize a segment in several parts for its numerical simulation of transient flows.

This detailed profile is used to correct line pack calculations based on measured node pressures. For networks with flow fluctuations, and/or for large networks, conventional assumption of linear pressure profile over a segment is inadequate and can introduce significant errors in shrinkage calculations. PAnORaMA does away with this source of error.

The shrinkage and line pack trends can be seen live along with pressure flow time series.

The shrinkage calculation is very scientific in its characteristics and can offer great confidence to the customers due to its transparency and rational basis. Based on the gas transmission agreements, bills can be prepared for individual customers on a daily, monthly basis. The bill amount can include charges based on quantity drawn, shrinkage apportioning and penalties for overdraw –underdraw etc. The bill formatting etc. would be customized as per organizational standards.

The billing can be automated based on the organization specific practices.



8. Forecasting and Scheduling:

Simulation can be used to whet the nominations for the next day to decide what the network can and cannot do. Allocations can be made accordingly. This allows optimal usage of pipeline capacity without getting into bad situations. Use of simulation power can offer a pipeliner great advantage in driving his gains to maximum within the resource.

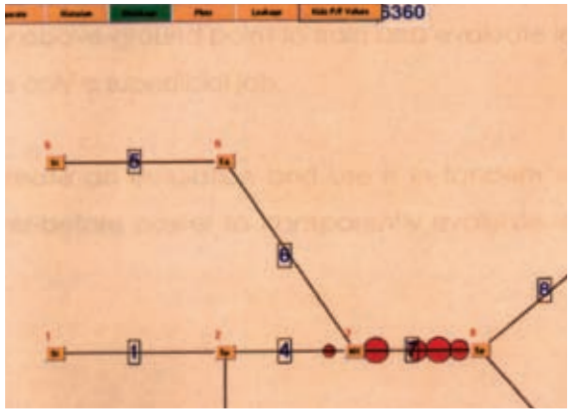
9. Leak Detection:

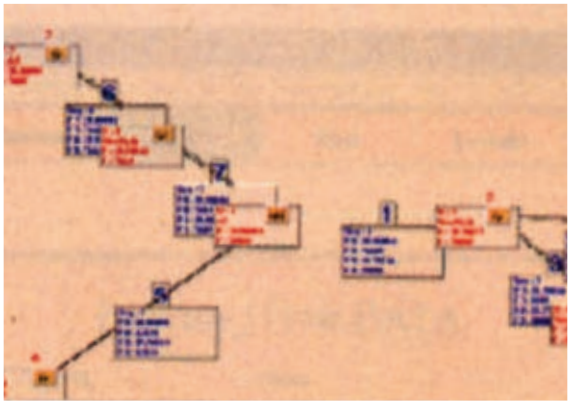
PAnORaMA has a unique simulation-based leak detector. Unlike the conventional and old philosophy of P-Q or Q-P based leak detection, PAnORaMA's leak detection is based on pre-simulations, pattern recognition and several supportive artificial intelligence-based techniques.

Using the emulator to synthetically create leakages and the simulator to predict performance under similar operating conditions without leakage, the leak detector can be trained and tuned to precise and timely leak detection with minimal spurious alarms. Minimal accuracy levels expected of instruments as well as optimal location of instruments which would optimize the accuracy of leak detection can be arrived at through systematic simulation-emulation based experimentation.

Any leak detector requires training to improve its reliability. Pipe Leak Detection techniques have often been found wanting in crunch situations. Spurious alarms are not good for operator confidence. PAnORaMA supports training of the leak detector at first stage using the simulation-emulation combine. Leak is created on emulation and the detector is thrown a challenge to detect it. Some parameters of the pattern recognition and AI technique used by us can be tuned with this exercise. As leak detector training is on emulation, its effectiveness to detect leakages over any part of the network (including underground sections) can be adjudged more comprehensively. The technique where leakage is created on any above-ground point to train and evaluate leak detection philosophy does only a superficial job.

PAnORaMA's facility to create an emulation and use it in tandem with simulation provides a never-before power to transparently evaluate leak detection accuracy. Leak detector of PAnORaMA is the best use of modern concepts of fault detection and diagnosis woven around a realistic simulation of the network.





2. Network Data:

Characteristic data for the network is provided as node data and segment data. Segment data includes diameter, length, surface roughness etc. Node data includes tag of the node, the type of node (start, end, splitter etc.), segments associated with any node, etc. The data is entered through very intuitive forms that pop-up for the segments and nodes in any user chosen sequence. Network data relevant from hydraulics point of view is provided through this module.

For advanced users, the same data could be uploaded through a pre-created spreadsheet or database.

PAnORaMA stores the network specifications in a database. A network can thus be retrieved, edited, saved, saved-as etc. PAnORaMA strives all the time for 'look and feel' of a typical Windows application or even better. Being an application conceived and developed by domain people, its intuitive navigation is unique and unsurpassed.

3. Flow Data:

The flow medium specifications are specified here. Fluid characteristics such as density, viscosity etc. at standard conditions are provided. For liquid systems, volume modulus of elasticity is also provided, which is important from the point of view of water hammer calculations. For start nodes where fluid enters the network, user may provide fluid properties separately.

PAnORaMA estimates properties at flow pressure temperature conditions using property estimators which can be built-in.

User also specifies the conditions at the start and end nodes as well as equipment characteristics such as pressure set point at Pressure Reducing Station, pressures at fluid entry points, or allocation or flow schedule at user nodes etc. These act as initial and boundary conditions for the network simulation.

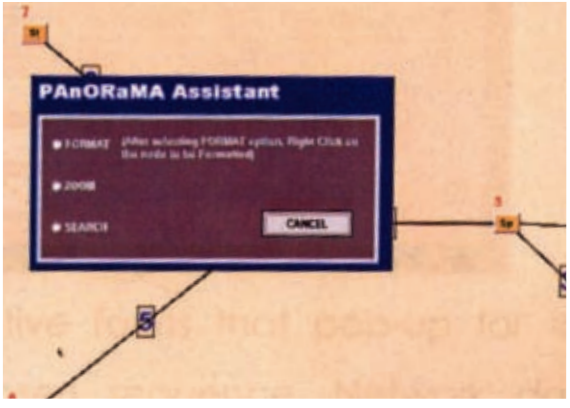
4. Simulation Engine:

With the network defined and initial and boundary conditions specified, transient simulation of the network flow can be carried out.The simulation generates steady state performance if boundary specifications (pressure at start node, flow at end nodes etc.) are held constant. It also generates transient performance for given schedule of supplies to users. Pressure and/or flow time series at all points along the network can be viewed to ascertain if the network can sustain a scheduled demand.

The simulations can be used to size various segments in the network for given supply regime, to test network's ability to support peak demand, to decide allocation, for forecasting etc.

PAnORaMA is based on a very robust simulation engine for flow of gas or liquid in a pipe network. The flow network can be a tree network or network with one or more loops. The simulation engine is developed by Piping Engineering Cell, IIT Bombay. The simulation engine is based on first principle transient model of compressible or incompressible fluid flow in a user defined network.

PAnORaMA is an object oriented implementation and supports most requirements of piping network design, operation and maintenance. It is specifically suited to cross-country pipeline community.



Important modules of **PAnORaMA** are described in brief in the following.

1. Network Definition:

An existing or proposed network can be created using this module. A built-in, simple to use application allows the user to draw a network and provide its dimensional features such as length and diameters of various pipe sections along trunk, spur and branch lines. The network is envisaged as comprising of 'nodes' and 'segments'.

Each segment is a uniform diameter pipe section of given diameter and length joining two nodes.

PAnORaMA supports six types of nodes, namely, Start, End, Mixer, Splitter, Intermediate and Equipment nodes.

Start node is where the fluid enters the network. There could be several start nodes implying that the fluid is sourced from different sources.

End Node is where fluid leaves the network. These are typically locations where a client draws fluid from the network at allocated/metered rate.

Mixer Node is where two incoming streams commingle and flow in a downstream segment.

Splitter Node is where a flow splits into two and travels in two different downstream segments. This node type essentially allows branching off.

Intermediate Node is where pipe specifications may change or where a measurement of flow or pressure is made etc.

The flow does not start or end or split or merge here but merely continues downstream.

Equipment node supports incorporation of any law which changes the attributes of flow. This could be a control valve, compressor, pump, pressure reducing station, pressure relief valve, vacuum relief valve, air chamber, non-return valve, expansion joint etc. Any other equipment type can be incorporated as per user requirement.

Any network can be visualized and created in a very intuitive and user friendly way. The network can be expanded to add more nodes and segments, to change the nature of existing nodes (intermediate to equipment, start to mixer, end to splitter etc.) and thereby extend the network to add more users, supply sources, etc.

Similarly, an existing segment can be split into two segments allowing for future branching off etc.

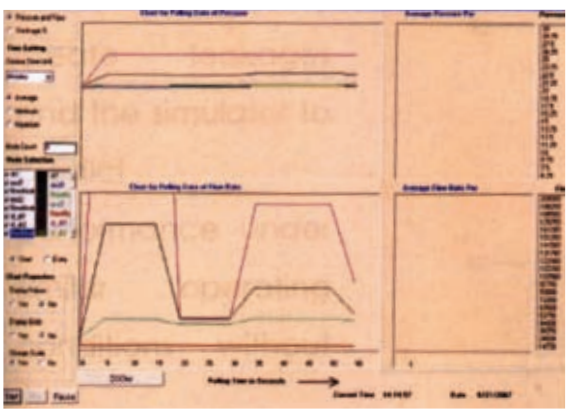
With this network expansion facility, PAnOraMA becomes an extremely powerful tool for operators with expanding networks.

Many user friendly features are available to spruce-up the network or visualize the network differently such as by aligning nodes, moving nodes, zooming-in, zooming-out, fitting to screen, locating node, locating segment etc.

10. SCADA:

PAnORaMA has full software support for SCADA system. If field parameters reach control room and time-stamped data on pressures, flows rates, temperature are available in analog/digital form, it can be processed by PAnORaMA to filter noise, show trends, do averaging for a minute, hour, day, month, quarter, year etc., prepare historian, give hi-lo alarms etc. The SCADA screens can be set up at any or all operator nodes as well as master console as per user perceptions and choice.

With the SCADA software support available as a part of PAnORaMA, what remains to be provided for is a PLC. PAnORaMA's SCADA support opens up possibilities for a low-cost SCADA system for any small or big flow network.



11. And More:

PAnORaMA being an object oriented implementation and expertise being available indigenously, the user can get it customized to the organization's specific needs and practices. What is offered is not an off-the-rack product, but a very specific user-centric solution.

Integration of PAnORaMA with any in-house or legacy software, web-enabling of some or all modules, knowledge process outsourcing, supply of PAnORaMA with requisite computer and/or SCADA hardware etc. are some concepts which PAnORaMA is open to.