PSIG Pipeline
Simulation
Interest Group

Recommended Practice for Software Acquisition

PSIG 003/2000

Objective: To develop a set of practices that may be used in the acquisition of pipeline simulation software.

Contents

Software Acquisition Practices Standard

1 PRE-PREFACE

1.1 Pre-preface

This Recommended Practice for Software Acquisition is written with reference to the descriptions of Steady State, Transient State both Off-Line and On-Line Analysis as stated below. These descriptions of the software should be used for reference when using this document.

1.2 Steady State Analysis

Steady State simulation software refers to software that does a single simulation for a single instant in time with all elements assumed to be at constant flow conditions at that instant. These simplifying assumptions of Steady State Analysis software do not allow for any time factors or variations to enter into the simulation.

1.3 Transient State Analysis

There are two kinds Transient State Analysis Simulation Software and both are described below.

When a pipeline system is subject to significant changes in flow rate, pressure conditions, or prime mover availability over the course of time, it becomes necessary to move beyond the simplifying assumptions of steady state flow simulation. A transient model simulates real-world conditions found in the system that vary with time, such as: load profiling by varying the flow rate according to normal diurnal swings in usage patterns; tracking pressure changes caused by the opening and closing of valves, especially on liquid pipeline systems; or optimizing power costs by starting and stopping pumps or compressors at certain times of day to take advantage of lower energy rates.

1.4 Off Line Non-Real Time Simulation

Transient State, Off-Line, Non-Real Time Simulation refers to a software system comprised of multiple simulations and applications integrated into a software suite.

In this type of modeling, the software usually derives a transient solution to a set of parameters described by an input file created by the user. In most cases the conditions on the pipeline are first modeled for an initial steady state, then the user's input file changes conditions that vary over time. The user can control the model with changes that vary over time periods ranging from seconds to hours. The goal of transient Off Line modeling is to either reproduce real-world conditions for optimization of system utilization, or investigating scenarios to determine system response to various emergency situations.

1.5 On-Line Real Time Simulation

Transient State, On-Line, Real Time Simulation typically refers to a software system comprised of multiple transient simulators and applications integrated into a software suite. The software suite provides for the exchange of information between simulators and applications, and provides a common user interface for all components in the suite.

A transient on-line model is the foundational component within the suite and its function is to accurately simulate the current operation of the pipeline system as it varies in real time. This simulation is performed using on-line measurement data, supplied through an interface between the model and the SCADA system. The result of this simulation is a continuously updated transient state of the pipeline system. This or these transient states are then made available to

other applications and simulators in the software suite for the purpose of operations analysis or operations planning. The other applications and/or simulators included in the suite will depend on the pipeline companies needs in these two areas.

Need's related to operations analysis will potentially result in applications or simulators such as:

- Leak detection
- Pressure analysis
- Composition tracking
- Batch tracking
- Tuning and data validation
- Trending and profiling

- Compressor/Pump simulation
- Look ahead modeling
- Inventory, line pack, and/or capacity monitoring
- Pig and/or scraper tracking
- Power monitoring
- Load/supply forecasting

Need's related to operations planning will potentially result in applications or simulators such as:

- Load/supply forecasting
- Predictive modeling
- Power/fuel optimization

On-line transient much more than off-line steady state or off-line transient is focussed on applications surrounding models. The predictive and look ahead simulators also have applications performing things such as composition/batch tracking, pressure analysis ,and inventory analysi. Within themselves, the look ahead, predictive and optimization models function as "off-line" simulators. But because of their integration with the on-line model they are typically considered to be a part of the integrated "on-line simulation suite".

2 PREFACE

A company considering the widespread implementation of new software must define and follow a number of steps. Those steps (including some variances) are addressed in this document. The basic stages that contain those steps are:

— Research, Identification, and Development of Software

— Purchase of Software

2.1 Terminology

All terminology used in this document that is not common to the general public's understanding shall have meaning as defined in PSIG Common Language Standard PSIG 001/1999 (A).

2.2 References

There are a number of steps in this Standard that may not apply to a company's particular situation. This document assumes a minimum level of understanding of the needs for — and uses of — Simulation Software by those using this document. All parts of this document apply to various aspects of the Simulation Industry and are important to someone. Please go on to the next step when you encounter a step or part that does not apply to you.

3 RESEARCH, IDENTIFICATION, AND DEVELOPMENT OF SOFTWARE

The subsections below identify software acquisition procedures and considerations that have been found to aid an acquisition team in the following areas:

— Selecting or developing the most appropriate software.

— Minimizing delays throughout the acquisition process.

— Maximizing the group effort and understanding.

— Providing the best overall and long-term software solution.

3.1 Considerations

The first and most important issues to address are the following:

— What do the users expect from the software?

— What purpose(s) will the software serve in the company's business functions?

A partial sample list of additional questions to be answered includes:

— Will it help to determine the amount of product that can be moved in an existing pipeline?

— Will it help determine the pressure required to move product in a pipeline under design?

— Will it provide for determination of system economics and incremental cost ?

NOTE: Only after the company's software requirements have been determined can the selection process begin.

3.2 Identification of Business Needs and Stakeholders

Identifying the basic business needs and stakeholders for a steady state software program is the first step. Companies that may be considering acquisition of simulation software include the following:

— A pipeline company handling various products

— An LDC (Local Distribution Company)

— A chemical company plant/facility

— Other organizations with simulation needs

3.2.1 Business Needs

Proper software and its efficient utilization can help solve or better manage the following issues:

a) Growing number of complex gas supply transactions.

b) The growing complexity of the physical delivery system from wellhead to customer.

c) Unbundling of production, transmission, and distribution services.

d) Out dated, non-expandable, or non-adaptable software.

e) Changes to type of product(s) being modeled: gas, liquid, or multi-phase.

f) Opportunity to benefit from new or improved simulation software.

g) The need to replace existing software or hardware platform, or obtain a new tool where no software exists in the company.

3.2.2 Stakeholders

Stakeholders may include any, or all, of the following parties and/or departments:

a) Product Control

b) Product Supply & Operations

c) Product Marketing

d) Product Capacity Management

e) Long Term System Planning

f) Pipeline Engineering and Maintenance

3.3 Software Acquisition

Efficient software acquisition and implementation requires a group effort. Begin by performing the following project organization tasks:

a) Select a committee, group or individual to oversee and make simulation software acquisition.

b) Determine the need to use or not use a consultant for the software selection and acquisition.

3.4 Determining Software Requirements

The requirements of the software are determined from various business and departmental needs. Those needs are listed in the subheadings below.

3.4.1 Engineering

IMPORTANT: This subsection is to be applied within the limits of the applicable codes and industry practices.

The following subtopics identify possible uses for the software to aid in the engineering functions of the company:

3.4.1.1 Piping Design Functions

a) Pressure Analysis −

The ability of the software to predict pressure profiles at given equipment states and conditions of flow and fluid properties.

b) Throughput Analysis −

The ability of the software to predict flow rates at given equipment states and conditions of pressure at various locations on the system as inputs and loads on the system vary over time.

3.4.1.2   Various Station Design Functions

a) Pipeline Analysis –

The ability of the software to predict pipeline conditions with stations at various locations along the system and the ability to do steady state optimization for those locations.

b) Unit Analysis –

The ability of the software to predict pipeline response to various combinations of pump/compressor unit utilization.

c) After Coolers –

The ability of the software to predict the need for and response to cooling the fluid discharged from the station.

d) Pipeline Heaters –

The ability of the software to predict need for and response to heating the fluid discharged from the station.

e) Relief Valve Analysis –

The ability of the software to predict need for relief valves and predict responses to flow situations that may exceed pipeline safety limits or capacity limits of a company's own system, or that of a customer's connected system.

f) Station Pressure Loss Analysis –

The ability of the software to predict pressure losses across facilities connected to the system (including strainers, filters, pipe, and other equipment).

g) Additional Factors (as determined by the review committee).

3.4.1.3   Measurement Station Design Functions

a) Pressure Analysis –

The software should have the ability to predict pressure drop across the metering station at various flow rates determined by the customers' equipment or contract. This includes analysis of — but is not limited to — After Coolers, Pipeline Heaters, Strainers, Filters, and Filter-Separators.

b) Throughput Analysis –

The software should have the ability to predict flow rates at various combinations of inlet and outlet pressures

c) Piping Analysis –

Use for determination of the pipe size to met the design criteria.

d) Relief Valve Analysis –

Allow for the determination of the necessary relief valve capacity needed when using particular methods of relief valve capacity justification.

3.4.2 Planning

The following are possible uses of the software in planning the company's facilities and operations:

3.4.2.1 Network Analysis

a) Throughput Analysis −

The software's ability to solve complex networks should be evaluated including its ability to select and solve sub networks of the system, as well as branches and loops.

b) Pressure Analysis −

The software should have the ability to predict critical pressure locations, calculate inventory in sections of the network, and predict changes in pressure and inventory based on changes in inputs and loads, equipment, set points and other equipment.

c) Multiple Scenario Capabilities −

The software should have the ability to easily solve multiple "what-if" scenarios.

d) Stations Analysis −

The software should have the ability to add or subtract equipment at all stations as required to meet station set points and eliminate constraint violations. The equipment includes compressors, regulators, meters, etc. The software should also include the ability to show pressure lost and flow through the equipment.

e) Effect of Storage or Production Fields −

The software should have the ability to utilize storage and production fields to optimize throughput or minimize costs.

f) Line Pack Analysis −

−The software should be capable of calculating the line pack.

−The software should be capable of predicting changes in line pack based on changes in network conditions such as set points, equipment, line services, and crossovers. This is used where Line Pack may be required to meet swings in demand on the system.

− The software should be capable of the above as well as being able to utilize real time data in its calculations and display the results in a timely manner. It should also be able to provide the results to other software packages.

3.4.2.2 Cost Analysis

a) Contract Compliance (or least cost of product)

b) Incremental Fuel and Electrical Cost Evaluation −

The software should be able to provide a methodology to store and maintain the data necessary to calculate fuel and electrical costs for various equipment. It should also provide a method to store data for other parameters such as compressor performance maps and fuel curves that affect the performance and cost of operating the equipment.

c) Tracking product value or cost –

The software should be capable of assigning monetary value/costs to specific operations of equipment; these costs should include fuel usage. The software should be capable of accumulating the costs assigned to equipment in the process of simulating product movement from one point to another.

d) Calculating Incremental Costs –

The software should be capable of calculating incremental costs associated with moving another unit of product through a given location based on the cost assigned to equipment. The software should be capable of accumulating incremental costs in locations along the flow path simulated.

e) Contract compliance monitoring –

The software should be capable of allowing minimum and/or maximum pressures (associated with contract compliance) to be assigned to supply and delivery locations and to perform monitoring during transient simulation for violations of these settings.

f) Operational impact analysis –

The software should be capable of comparing costs calculated between different simulation runs on a location-by-location basis.

g) Reliability Analysis –

Cost of computer downtime, error correction, and inaccurate predictions of software.

3.4.2.3   Intermediate (Time) Planning

a) Modification of Master Plans –

Ability to simulate transient operations over the next one-hour to seven days using the starting point of the initial Master Plan to look at the effect of outages, nominations, forecasted supplies, and deliveries. Also, the ability to use transient results as a starting point for Master Plan transient models.

b) Capacity Analysis –

Ability to simulate capacity across the complete pipeline network or sections thereof and follow changes in that capacity over time.

c) Outage Analysis –

Ability to simulate planned outages and their impact on throughput. The software should also allow for the identification of bottlenecks, and allow for simulating and comparing alternate outage plans. The software should also be able to take snapshots of the models at a particular time with planned outages and perform steady state analysis on them.

d) Rupture Analysis –

Ability to simulate ruptures and compare alternate rupture action plans.

e) Storage Analysis –

Ability to simulate pipeline storage and field storage

f) Operational Analysis –

Ability to simulate alternate operations to determine the best operational strategy for the period of time being simulated.

g) Survival Analysis −

Ability to calculate the time until operational violations begin to occur as a result of a loss of major supply or delivery locations, and/or compressor outages.

3.4.2.4 Long Term (Time) Planning

a) Master Planning

The ability to easily update and maintain models and to create alternatives where necessary for design purposes. The ability to archive models if necessary and reuse at a later date.

b) Capacity Analysis

The ability to determine long term capacity based on future goals and design for the necessary equipment to meet those goals.

c) Outage Analysis

The ability to do future "what if" scenarios based on equipment outages, and to determine best alternatives and reduce capacity loss.

d) Rupture Analysis

The ability to allow for future scenarios and determine impacts of ruptures.

e) Storage Analysis

The ability to predict the capacity of a storage field to sustain expected peak capacities in market areas. It should also provide the ability to plan storage expansions to meet predicted capacity needs.

f) Operational Analysis

3.4.3 Scheduling

Uses of the software to determine impacts of load scheduling and flows in the facilities.

3.4.3.1 Nominations Scheduling

a) Capacity Analysis

b) Operations Forecasting

c) Outage Analysis

3.4.3.2 Bottleneck Identification

a) Throughput Analysis

Determine throughputs at various points on the system where SCADA equipment is not available.

b) Facilities Analysis

Identify facilities where bottlenecks occur and the conditions under which they occur.

3.4.3.3 System Optimization

a) Minimize Operating Costs

Provide a methodology to utilize steady state optimization in determining the equipment and equipment states where fuel costs are reduced both within a compressor station and across a system.

b) Maximize Throughput

Provide a methodology to determine maximum throughput at a given time and location on a system under a set of conditions that can change with time.

c) System Survival Time

Provide a tool to determine survival time of a model under various changes in throughputs, inputs and outputs and compression. Allows for determination of the "swing capacity" of a system.

3.4.4 Operations

Uses of the software in the operation of the facilities. Most of these uses require Transient State analysis software.

3.4.4.1 Operations Monitoring

a) Leak Detection

Uses online real-time simulation to detect a continuous flow imbalance.

b) Pressure Monitoring

Computes pressures at points on the pipeline, which do not have pressure measurement, and the maximum pressure may be exceeded. This can be both current and predictive.

This is important on liquid lines where there may be high static head differences, and when the flow rate is lower than design. It is also important on gas pipelines where a rapid load reduction will cause a pressure increase.

c) Rupture Lose Analysis

Both predictive and for estimating losses after an incident.

d) Line Pack Analysis

Can be on a steady state or transient state basis.

3.4.4.2 Operations Forecasting

a) Short Term Future Analysis

Determine change in operating conditions due to predicted load change.

b) Decision Support

Verify that bringing on, shutting off, or injecting into storage and turning on or shutting off compressors is timely and adequate.

3.4.4.3 Operations Optimization

a) Minimize Fuel Usage

b) Maximize Throughput

   c) Shift Line Pack (as needed)

   d) Bring on other sources of supply

3.4.4.4   Operations Changes

   a) "What If" Scenarios

   c) Incremental Cost Analysis

   Predict incremental fuel and electricity for incremental loads, in order to calculate the incremental cost and profit margin.

3.4.5   Maintenance

Software uses for facilities maintenance:

   a) Pipeline Replacement (may be included in Master Planning)

   b) Equipment Replacement (may be included in Master Planning)

3.5   Prioritize and Evaluate Information

   a) Describe the items above in terms of what input is available and the output required.

   b) Prioritize the items in the sections above and combine them into a list of software requirements. Identify which items in the list above are of the highest to lowest priority to the company and stakeholders.

Note: Testing to meet those requirements will be performed later in this process.

3.5.1   Evaluate the Personnel and Company

Evaluate the personnel and the company for the kind of software that fits the company's culture and requirements. Examples include the following:

   a) The culture may be to select the software and have a contractor run it. This may have elements in it that are very important when evaluating and selecting the software, as the software license must be written specifically to accommodate this usage.

   b) The company may have a distribution or transmission system with different complexities. How many nodes and/or legs can the software handle? How complex can the system be?

3.6   Define the Performance Metrics

Define the performance metrics needed for the software to meet the identified requirements. Categories include the following:

3.6.1   Output of Data

   a) Output in various electronic forms

      – List of electronic forms needed

   b) Functionality of output

      – Determine that the electronic forms met the functionality that is required.

   c) Timeliness of output

   d) Speed of program –

– Ability to handle complex systems starting with steady state or transient state data and parameters and running a model of the existing system without losing data or requiring the model to be simplified.

3.6.2 Input and Import of Data

a) By and from Spreadsheets

b) Other systems data storage

c) The amount of data that must be manually inputted

d) Re-use of input data

3.6.3 Integration with Other Packages Capabilities

The ability of the software to pass information to another software package (in a preferably seamless manner) — regardless of whether it's a simulation program other software package.

3.6.4 Sensitivity

How closely the values come together when solving the convergence tolerance limits of the software.

a) The ability of the convergence tolerance limits to be set or not set.

b) How close the values are when solving the convergence tolerance limits of the software.

3.6.5 Performance Metrics Documentation

a) Develop a Questionnaire or Checklist of the Performance Metrics.

b) Prepare and send a document to all vendors detailing the metrics that the software must meet.

3.7 Identify Potential Vendors

a) Vendors of which the company is currently aware.

b) Referals to vendors of whom you are unaware.

c) Acquire information from the potential vendors:

— On their products for the next step in this process.

— On their stability (financial health) to determine if they will be available in years to come.

d) Where applicable, allow for and follow government procurement directives. For example, in Europe there is a requirement to publicly advertise in the European Journal to ensure open tendering.

3.8 Product Analysis

Analyze the product offered by each of the vendors as per the [Software Requirements](#) section above.

3.8.1 Basic Analysis Capability

Test the ability of the product to analyze the system.

    a) Analysis run times.

    b) Time to load a network.

    c) Reliability of product.

    d) Compatibly with the existing run platform.

    e) Repeatability of the software run.

3.8.2 Database Capabilities

    a) Test for ability to share and manage data over a network.

    b) Security of data, use of passwords.

    c) Ability to review, interpret, read or obtain and enter into its model, data from other data bases. Such as the GIS AM/FM system, billing and special databases.

    d) Ability to supply data back to the above databases.

3.8.3 Network Capabilities

The company maybe organized over a number of sites that require transmitting data over a network, or the company may not have a network, but needs one. Furthermore, the importance of some information is such that only a few should be able to change it.

    a) Security of data, use of passwords.

    b) The ability to work with and in the network.

3.8.4 Documentation/Training

Including reference manuals, support theory, training manuals, and help facilities.

    a) Comprehensive and Thorough –

Test for comprehensiveness and completeness. All features should be illustrated and examples of usage given.

    b) Clarity of Documentation –

Clarity of writing style should be evaluated. The manuals should not assume too high a level of expertise, unless the product is specifically designed only for highly trained individuals.

    c) Usability Level –

Ease of use should be evaluated. A high level of online help should be available while running the system.

    d) Up to Date –

Current versions of manuals should be easily accessible to all necessary personnel. Only one or two errata pages should be necessary for insertion into a bound manual. If the manual is in a ring binder, no changes should be required.

All features of the latest software version should be incorporated into the written and online documentation.

3.8.5 Equations Used

a) Standard industry accepted equations

— Leg (or pipe segment) equations

— Node equations

b) Custom Equations (Proprietary Equations) –

Allow for use (or entry) of a user-derived equation in the software in place of a standard, industry-accepted equation.

Note: Allow for use or entry of a user-derived equation in the software in place of a standard industry accepted equation.

3.8.6 Error Handling - Failure of Model to Obtain Solutions

a) Identify failure(s) of model to obtain solutions

b) Resolution Assistance: Identify error messages and any other information provided by the software to the operator. For example, when a model fails does it tell the operator — in understandable terms — where the problem is or how to fix it or not?

3.8.7 Software Life Span and Growth Factors

a) Upgradeability of the software

– Can the software be upgraded and is the software company committed to upgrading the software.

b) Long-term maintainability or designed obsolescence

c) Future Benefits (for when the company grows)
– For each type of software.

d) Hardware and Software Limitations

e) Ability to Modify or Improve the Product

3.8.8 Software Warranty Terms

a) Length of term

b) Quality control

c) Guarantee of accuracy

Note: The software vendor should specifically state in writing that the software will perform to the specified matrices.

3.8.9   Cost of Technical Support (for all available service levels)

   a) Onsite Technical Support - (The ability to have some one on site quickly at low cost can be of concern. Therefore, the time zones must be considered.)

   b) Telephone Support - (The office hours to provide off site support can be of concern. Therefore, the time zones must be considered.)

   c) Training availability - (The ability and cost for on-site and off-site training.)

3.8.10 Usability

How easy is the software to use. This will have to be tested by the users themselves.

Note: Testing in a demonstration situation produces unrealistic results.

   a) Convenience

   b) Intuitive Feel for the Process

   c) Clarity of Displays.

   d) Ease to Get Answers.

3.8.11 Output of Data

   a) Output in Various Electronic Forms.

   b) Functionality of Output.

   c) Report Generation by Program. (Black & white or color.)

   d) Map printout by program. (Black & white or color.)

   e) Allow for Use of Current Standard Company Forms.

3.8.12 Importation of Model to Multiple or Different Software Products

   a. The importation of the software from Steady State to Transient State.

   b. The simulation software will allow for importation of different modeling cases from multiple software design companies.

3.8.13 TS Modeling Items

The software will provide a means by which the following items can be changed and evaluated:

   a) Data can vary over time (e.g., loads and compressor set points).

   b) The settings for action can be changed during the course of a transient analysis (e.g., starting and stopping compressors).

   c) The analysis times (such as starting, stopping, and intermediate) can be set.

4 PURCHASE OF SOFTWARE

4.1 Evaluation Reports

Produce from the above evaluation steps the evaluation reports or decision. Do this determining which vendors can meet all the simulation software needs of the company. If no vendor can meet the above needs satisfactorily, determine what alternate solutions are available.

4.2 Software Pricing

Follow the standard price solicitation and purchase policy of the End-user Company.

Note: This is normally the final step before acquiring the software. The exception is when the process is terminated or started over at some level.

4.3 Acquiring the Software

The company will acquire the use of the software according to the company and vendors standard procedures applicable to the given situation. The procedures may include such items as the following:

a) Send Out Purchase Order or Sign Letter of Intent.

b) Train Operators in Use of Software.

c) Inform Non-selected Vendors the Results of the Selection Process.