

# *Xpert* **IRENE**

## The Right Software Tool for Analysis of Your Gas Networks

The powerful AM/FM/GIS software package for calculating and analysing gas pipeline networks. A unique combination of gas technology and information technology.

The energy sector is changing rapidly. Deregulation, unbundling of network operating and trading companies, alternative sources of energy. Developments that have been initiated in recent years and will continue without abatement. New developments will undoubtedly follow.

Companies must be able to anticipate these developments quickly and adequately. This requires top quality service, especially also because customers want to have insight into the services offered and costs charged.

The basis for such a sound service is a high-quality network infrastructure that guarantees safety and security of supply at minimum cost. This in turn requires the availability of proper network data.

And that's where IRENE Xpert comes in. This state-of-the-art software package is designed especially for analysing gas pipeline networks. It includes specialist modules for network capacity calculations, network design and security of supply analyses. Gas pipeline networks can be calculated both in

their present configuration and in scenarios in which the network is changed. The results can be displayed in graphic form enabling a quick review of the scenarios.

With a long history of calculating and designing gas pipeline networks Kiwa Gastec Technology guarantees you top quality.

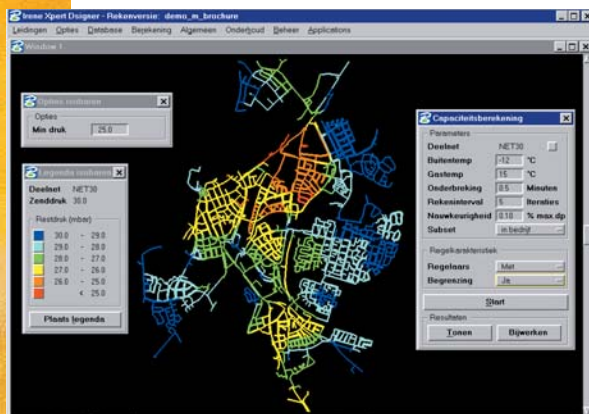
IRENE Xpert offers three modules:

*Xpert* **ST**  
**IRENE**

*Xpert* **Dsigner**  
**IRENE**

and

*Xpert* **CML**  
**IRENE**



*Insight at a glance*

### Benefits of IRENE

- effortless calculations with more than 100,000 pipelines
- rapid, reliable calculations and displays
- many adjustable calculation parameters
- smooth communication with your systems and data
- excellent customer support
- easily scalable
- user-friendly interfaces
- proven track record since 1995

IRENE Xpert ST is a valuable tool for analysing your gas pipeline networks. It is a powerful software package combining gas technology and information technology.

In addition to the extensive possibilities of IRENE Xpert ST, IRENE Xpert Designer offers you very valuable support in designing new gas pipeline networks. It is a unique package that allows you, for example, to determine the optimum diameters of a network.

Finally, IRENE Xpert CML will add risk analyses to the IRENE Xpert ST module. With the CML module you get a very good insight in the sensitivity of your gas network.

### Example 1

You know about the annual maintenance costs of a gas pressure regulating station. You may ask yourself: Can these costs be reduced? By how many stations is this network section actually supplied? Can I do with fewer stations in this section?

IRENE Xpert can help you answer these questions. You can calculate the effects of different network section scenarios, not only in its present configuration but also in scenarios in which one or more stations are put out of operation. The results such as pressure distribution, flow rate and pressure drop can be displayed in graphic form immediately showing which stations can be put out of operation without a hitch.

### **Example 2**

Many cast iron mains that are in urgent need of replacement are buried in a certain part of a city. Can these be replaced by smaller diameter mains? Will the pressure drop on the periphery not be too big?

IRENE Xpert ST allows you to change the diameters of the pipelines and compute the network again. IRENE Xpert Designer makes it possible to calculate the optimum diameters coupled with the materials you prefer. Not only for individual mains, but also for complete networks. The results, for example the calculated pressure drop, can be displayed graphically in colour and number.

### **Example 3**

Is it possible to add new consumers to the existing distribution network without any consequence? Is it necessary to make a new branch for a bulk consumer or will an additional distribution main do? How big is the gas off-take of other large-scale consumers in this section?

IRENE Xpert helps you answer these questions too. Gas off-take and position of each large-scale consumer in a network section can be shown in a simple manner. Just add the expected gas off-take of the new consumer and you can determine the effects for the network section in its present configuration.

You can also assess the consequences, for instance, if a new consumer is supplied from the nearby transmission network using a branch connection. The results of these and other possible scenarios can be compared and analysed.

### **More possibilities offered by IRENE Xpert:**

- Computing your network using a different gas mixture, for example in the case of hydrogen addition;
- Computing your network with limited station capacity;
- Display of network data coupled with, for example, topographic data, soil quality or cadastral data;
- Insight into asset data such as position, year of construction, type of material, etc.

### **Save costs with IRENE Xpert**

The incorporation of IRENE Xpert into your corporate processes will yield cost savings both directly and indirectly. Directly because it allows you to immediately pinpoint the bottlenecks in your network. Indirectly because it simplifies and speeds up network calculations under different circumstances. It provides a better understanding of the behaviour of your network, which definitely is an advantage when renovating existing or constructing new networks.

# IRENE Xpert within your company

Within energy companies, IRENE Xpert is not a self-contained information system. It is part of a Distribution Information System, which in itself is part of the comprehensive corporate information system. In this way, data can be exchanged between IRENE Xpert and other information systems, for instance the Customer Information System.

IRENE Xpert is employed in the departments of an energy company tasked with the planning, design and management of gas pipeline networks. Managers of infrastructure, network control, project bureau and drawing office; network designers, calculators and draughtsmen: IRENE Xpert will undoubtedly provide added value to all of them. IRENE Xpert is a key instrument in support of management decisions, although it can also be of assistance in a great deal of the day-to-day operations of an energy company.

## IRENE Xpert is scalable

IRENE Xpert can be used in two ways within a Distribution Information System. First, purely as a specialist application, where the input data IRENE Xpert requires comes from the Asset Information System (AM/FM/GIS). In this situation it is used to manage asset data. In such a Distribution Information System the operations are supported by self-contained and tailored

applications, which are generally not integrated into a single overall system.

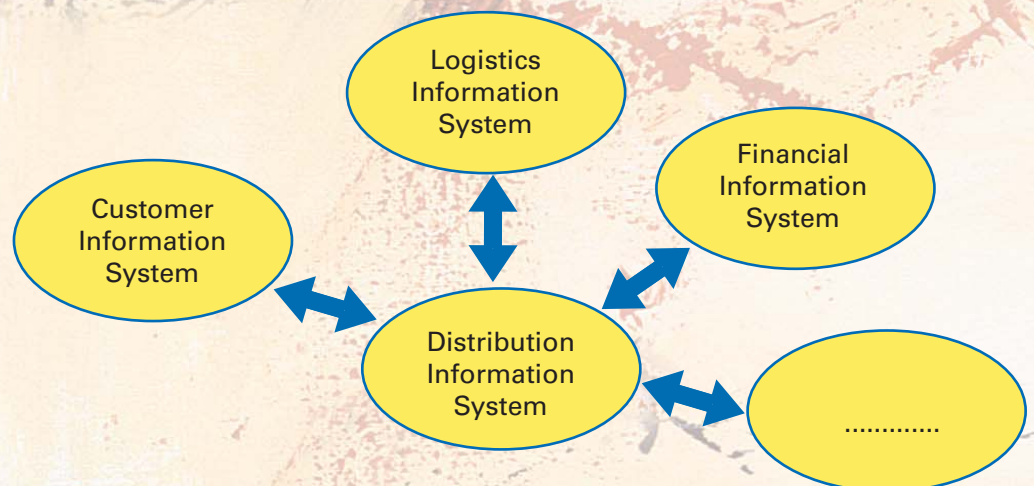
Secondly, IRENE Xpert can also be used as a combination of a simple Asset Information System and specialist application. In this configuration, IRENE Xpert will not only be used for analysing, calculating and designing gas pipeline networks, but also for their management and control.

IRENE Xpert is designed especially for analyses and calculations. A typical precondition of network studies and analyses is that it must be possible to change the network data. It is not desirable, however, to make these changes in the databases that contain the actual situation of the network. Consequently, a separate environment must be created to be able to perform these network calculations. This is included as one of the functionalities and is referred to as 'calculation version'.

## Open database

How many databases relating to your gas pipeline network do you manage within your company? How often do you store the same data in all these databases? Are you sure that all these databases are properly kept up to date after revision?

The assets of a company are its capital and will be managed based on asset data. It is of



*Relationship between Distribution Information System and other information systems within an energy utility*

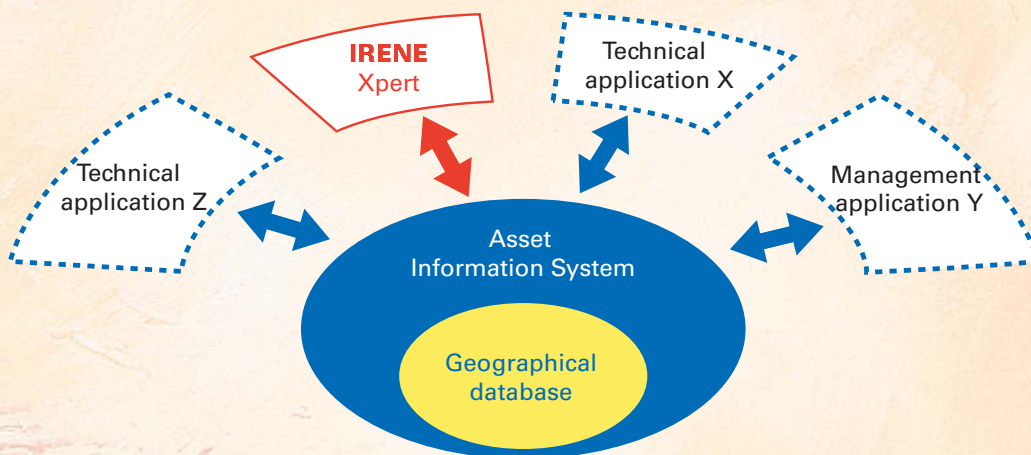
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vital importance that you can decide how to use this data. You should not be limited or even hindered because it is stored in a program-specific file format, making smooth interaction with other applications impossible. That's why IRENE Xpert has an 'open' database. In other words: the information stored in this database is freely accessible to other programs applied within your company.

### Standard software

Kiwa Gastec Technology believes in the power of standard software. Software that serves as a standard to all kinds of users, but is flexible enough to meet the needs of individual clients. IRENE Xpert itself is a standard package. In addition, it uses other standard packages: the graphics package MicroStation and Oracle's relational database management system (RDBMS).

In the first half of 2007 the new version of IRENE Xpert will have its own graphic display function and will be able to communicate with other databases, next to Oracle.



*Position of IRENE Xpert within a Distribution Information System*

# IRENE Xpert: simple and clear

The concept of IRENE Xpert is simple and clear. The basis is formed by an open, geographical database, in which all the relevant network data are stored. The level above it – the program level – comprises specialist modules and functions for the management, analysis, design and calculation of gas pipeline networks. The networks and the results of analyses and calculations can be displayed via the program level. The modular structure of IRENE Xpert makes it possible to easily extend the program with new functions and modules.

## Data management in IRENE Xpert

The geographical database in IRENE Xpert is divided into one main version and an unlimi-

ted number of subversions termed calculation versions. All the original data is stored in the main version. This data represents the actual situation of the network. The calculation versions are copies of parts of the original database selected by the user. Network calculations can only be performed in these calculation versions. The calculation versions are copies so that users are free to manipulate data and simulate and calculate different network scenarios. Because calculations are only permitted in the calculation versions and not in the main version, the actual situation of the network will never get lost. IRENE Xpert has been designed especially to manage the data that is crucial in analysing, calculating and designing a gas pipeline network.

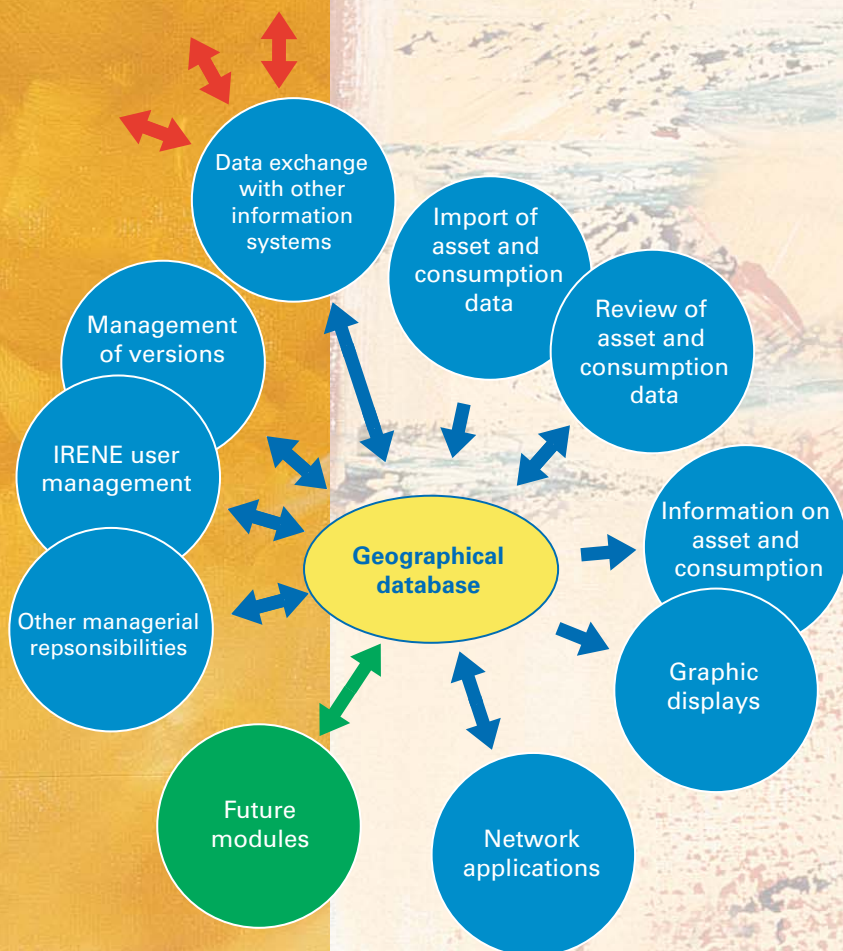
The assets to be stored include:

- pipes, with data about material, diameter, length, year of construction, status (in/out of operation, projected, designed) and derived data such as domestic consumption and flow rate;
- stations, with data about inlet and outlet pressures, status (in/out of operation), limit values, name, number, regulator, theoretical and calculated capacities;
- valves, with data about their status (open/closed).

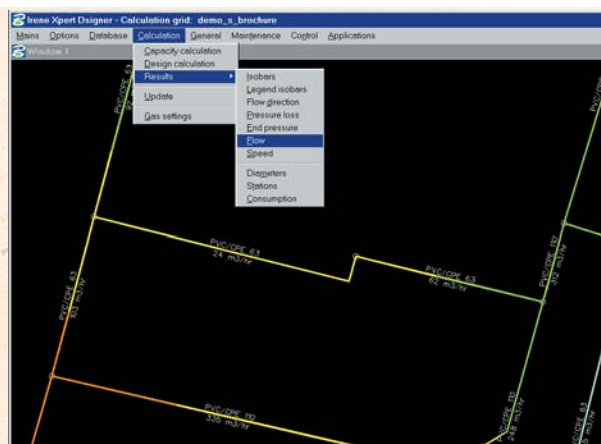
Other data include:

- nodes, for example pressure drop;
- large-scale consumption, divided into a temperature-dependent and a temperature-independent part;
- materials, with diameters and K-values;
- consumer groups, small consumers with peak hour demand and large-scale consumers with a factor for simultaneous use.

Moreover, IRENE Xpert itself ensures that the logical network structure is maintained.



The modules of IRENE Xpert



Graphic display possibilities for many different results

### Modular design IRENE Xpert

The modules in IRENE Xpert are fully menu-driven, i.e. they can be started using the main menu and pull-down menus.

The following modules are available:

- Import of asset and consumption data, including features for:
  - digitising, extending and dividing mains;
  - positioning valves and stations;
  - incorporating digital topographical backgrounds.
- Review of asset and consumption data, including features for:
  - opening/closing valves;
  - putting stations in/out of operation;
  - limiting station capacity;
  - changing consumption data.
- Asset and consumption data, including features for:
  - retrieving individual asset data;
  - retrieving data on assets in a given area;
  - searching assets.

- graphic displays, including features for:
  - positioning isobars and corresponding legend;
  - positioning pressure drops or residual pressures;
  - positioning flow rates and velocities.
- network calculations, for computing the capacity of gas pipeline networks, including features for:
  - adjusting calculation parameters;
  - calculations using different gas mixtures;
  - calculations using the control characteristic of a regulator and limited station capacity.
- Data exchange with other information systems, for example for importing current asset and consumption data from the Asset and/or Customer Information System.
- Management of software versions: IRENE Xpert is divided into one main version containing the original data and an unlimited number of subversions or copies of parts of the original database selected by the user; calculations can only be performed in these subversions.
- Management of IRENE Xpert users, to assign access rights based on the user's job, for example access rights for network calculators and draughtsmen.
- Other managerial responsibilities, such as
  - management of material listings;
  - management of consumer groups;
  - management of regulators and associated control characteristic;
  - management of network sections;
  - verification of asset data.

# Network calculations explained

IRENE Xpert is first of all a package for analysing gas pipeline networks. A key element is the evaluation of the network capacity. In this section we will describe in more detail the technical possibilities of network calculations made with IRENE Xpert. The description applies to IRENE Xpert ST, IRENE Xpert Designer and IRENE Xpert CML.

## The heart of IRENE Xpert network calculations: the computation method used

The methods used in network calculations can be split in two parts. The first part deals with methods for calculating the pressure drop in pipelines. These methods are derived from fluid dynamics. IRENE Xpert performs calculations using the formulae for compressible flow. Use is always made of the Reynolds number. The friction factor is determined by means of the iterative formula of Colebrook and White, which already includes the Reynolds number.

The second part is concerned with methods for computing an entire network. Meshed networks are less easier to calculate than branched networks. For calculating meshed networks an iterative computation method is employed, the so-called Hardy Cross method. Input data for calculations include position and quantity of consumption, position of pipelines and stations, diameter and wall roughness of each pipeline and outlet pressure or control characteristic of stations. Output data of calculations include pressure

drop and residual pressure across the network, flow rate, direction and velocity of flow in the pipeline and actual outlet pressure and flow rate of the stations.

## Parameters

Many calculation parameters can be adjusted to suit your needs. In the calculation start-up screen the following parameters appear:

- outside temperature to adjust the temperature-dependent part of consumption;
- gas temperature because pressure drop is a function of gas temperature;
- final computing accuracy to set the best combination between computing speed and accuracy;
- interval for re-assessment of the friction factor to set the best combination between computing speed and accuracy;
- control characteristic to determine the actual sendout pressure of a station;
- capacity limits, to set the capacity of a station's regulator to its maximum value;
- gas parameters to adjust gas viscosity and density.

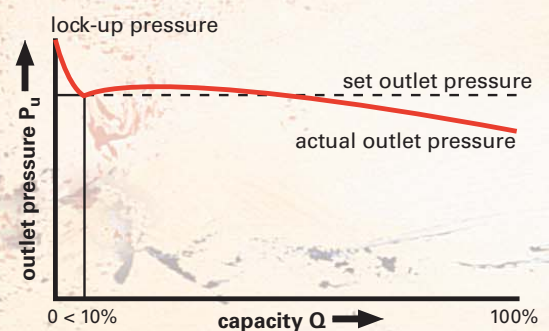
## Advanced display tools help you analyse the calculated results

IRENE Xpert has various tools to accurately display the calculated results, including:

- Isobar add-on, where pipelines are displayed in colour corresponding to the prevailing residual pressure;
- Information given at nodes: pressure drop or residual pressure;
- Information given along the pipeline: flow rate and velocity;



Calculations with the actual outlet pressure of stations



# in greater depth

- Tabular information (in a legend), such as diameter distribution in the network, consumption divided into categories;
- SQL queries enable the carefully directed retrieval of calculated results from the database. SQL stands for Structured Query Language and is a standard language for retrieving and manipulating data in a database.

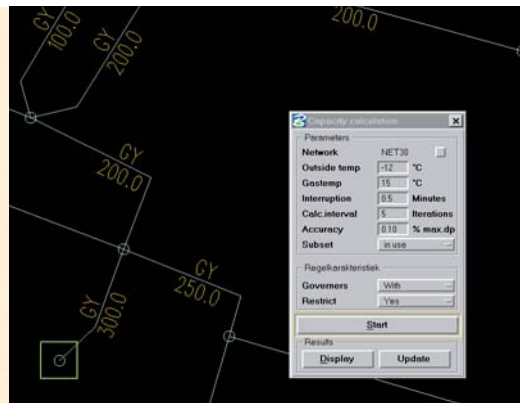
## IRENE Xpert Designer

An important add-on to the analysis tools of IRENE Xpert ST is the Designer module for dimensioning gas pipeline networks. This section describes in greater depth the technical possibilities of this module.

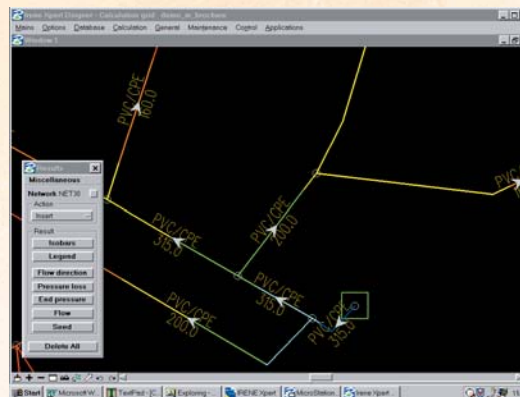
Dimensioning pipelines can in short be defined as 'determining the optimum diameter of pipelines'. By analogy, dimensioning a pipeline network is similar to 'determining the optimum diameter distribution in the pipeline network'. The terms 'dimensioning' and 'design' are often mixed up because dimensioning is a key element in the design process. Designing pipelines and networks, however, involves many more aspects than just dimensioning. An example is the selection of the route which is one of the design stages but falls outside the dimensioning process.

Optimisation always requires optimisation criteria. In dimensioning pipeline networks two such criteria are used:

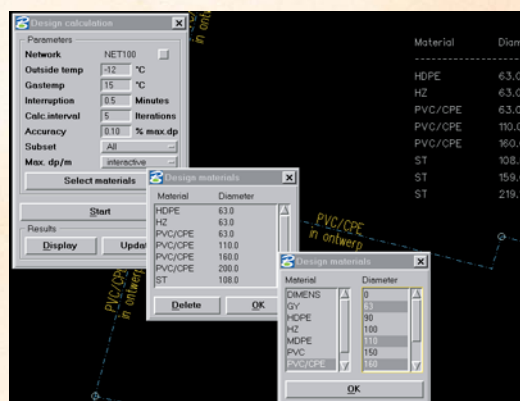
- Gas should be transported by the shortest route from feed point to consumer.
- The lowest network costs are obtained with constant fall, i.e. a constant pressure drop per metre of pipe.



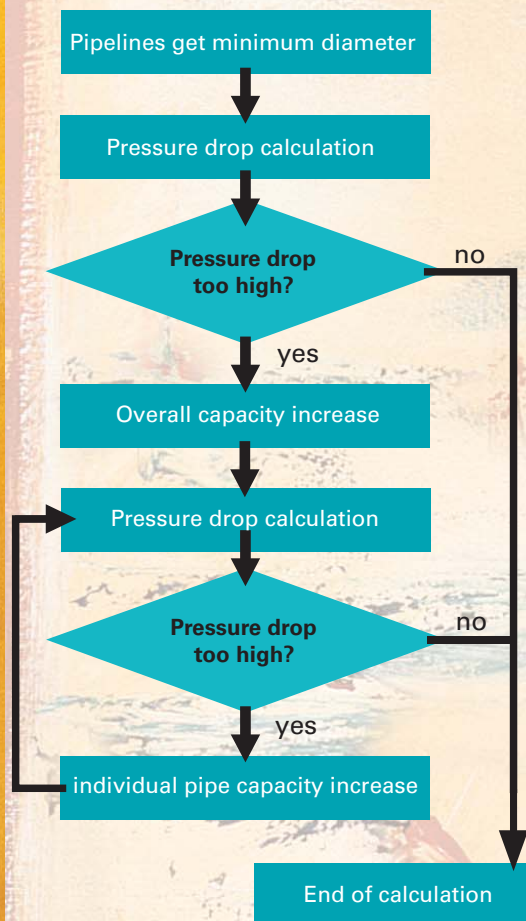
Adjustable calculation parameters enable customised calculations



Calculation results are displayed as desired



Unrestricted choice of diameter strings for each material



### **Overall capacity increase**

The pressure drop per metre of pipe, among other things, has been calculated in the first capacity calculation. In this way, all the pipelines got their minimum diameter. At the next stage, overall capacity increase, the pressure drop per metre for each individual pipeline is compared with the permitted pressure drop per metre of pipe chosen by the user at the beginning. The pipeline diameter is then increased until the pressure drop is lower than the permitted value. This increase is applied to all the pipelines.

### **Individual pipe capacity increase**

After each capacity calculation the points with excessive pressure drop are determined. For each of these points it is established which feed point supplies the most gas and by which route. It is then determined which pipeline from the branch has the biggest pressure drop per metre. The capacity of this pipeline is increased. In this way, all the points with excessive pressure drop are dealt with. Once the capacity of the pipelines concerned has been increased, a new capacity calculation is carried out.

IRENE Xpert Dsigner has all the same tools for the representation of results as IRENE Xpert ST. In addition, the calculated diameters can be displayed. The colours in the graphic display correspond with a specified diameter range. The numeric values of the diameters can be displayed along the pipeline. The diameter results can also be shown in tabular form.

### **IRENE Xpert CML**

The CML (Customer Minutes Lost) module will add risk analyses to the IRENE Xpert ST module. CML is calculated by removing all pipelines and gas regulation stations one by one at different temperatures. Also it takes into account the downtime of the specific network component. The result is a CML value for every pipeline and station in your gas network, presented graphically.

The benefits of this CML module are that it:

- gives a very good insight in the sensitivity of your gas network
- helps to reduce downtime (and penalties), resulting in cost reduction and higher customer satisfaction
- gives support in decisions about the format and placement of gas reduction stations
- tells you the optimum diameter for a new pipeline based on risk

# Years of experience

The AM/FM/GIS software package IRENE Xpert is the result of a wealth of know-how and experience collected over many years in the field of gas technology and information technology.

Since its beginnings, Kiwa Gastec Technology has been actively involved in the design, planning, construction, operation, management and maintenance of gas pipeline networks. Network calculations have always been a key element in these activities. However, network calculations are cumbersome and time-consuming. Kiwa Gastec Technology quickly realised that these calculations could best be automated. At the end of the 1960s Kiwa Gastec Technology developed the first version of the computing

program. It has since been further developed to keep abreast of developments in information technology. In the 1970s it was still purely a computing program that ran on mainframe computers. With the rise of personal computers in the 1980s it was then converted into a computing program suitable for PCs. In the early 1990s the program was embedded in a comprehensive GIS program with features for operation, analysis, calculation and display of geographic data. This comprehensive program was called IRENE. During the first few years IRENE ran on UNIX platforms. Since 1995, Windows is IRENE's primary platform. A standardised version, named IRENE Xpert, was brought to the market in 1999.

## Technical specifications and general information

- Operating system: Windows
- Database: several options possible, including Oracle
- Graphics package: Microstation, or graphic display package developed by Kiwa Gastec Technology (from half 2007)

IRENE Xpert can be installed on a stand-alone PC with all the software and data available locally, but also in a multi-user network/client-server environment. The Standard Exchange Format IRENE Xpert (SEF IRENE Xpert) makes it possible to exchange data with IRENE Xpert. This exchange format is based on NEN 1878, a Dutch standard for exchanging spatial data. More technical specifications of SEF IRENE Xpert are obtainable from Kiwa Gastec Technology.

Kiwa Gastec Technology has planned to extend the options for data exchange with a format based on XML. It is scheduled to have this new data exchange format finalised in IRENE Xpert in the course of 2007.

We also offer you the possibility of a software servicing contract. In this way, you are assured of a program that keeps pace with technological developments and the ever changing user needs. Another benefit of such a servicing contract is that you have the back-up of our telephone services and helpdesk.

### Training and Additional Consultancy

In preparation of the optimum use of IRENE Xpert we offer you the following services:

- turnkey design and installation of hardware and software IRENE Xpert platforms;
- customized installation on site;
- IRENE Xpert training; after a short instruction period your staff will be able to use the functions of the package to best effect.

In addition to our IRENE Xpert software, we can advise you on the development and operation of your Distribution Information System.

### *For more information*

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#### **Profile of Kiwa Gastec Technology**

*Kiwa Gastec Technology is a service company with an international reputation in the area of gas technology, including natural gas, LPG, biogas and hydrogen. The activities comprise consultancy, engineering, training, product development, and the construction of components, equipment and systems for the extraction, distribution and utilisation of gas. The market served by Kiwa Gastec Technology consists of gas production, transport and distribution companies, power companies, energy-intensive businesses, the gas and heating equipment industry, and other companies that require gas-related expertise. Kiwa Gastec Technology is based in Apeldoorn.*

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