Gas Supply and Storage Planning: A Simulation Approach

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This paper describes the problems faced by a region of British Gas in forecasting daily gas demand and gas storage requirements. The discrete simulation approach is used to model the gas supply system. The paper discusses how the relationships and interactions between the various parts of the system may be determined by using the simulation program which has been developed and implemented.

INTRODUCTION

The gas supply function of the North Thames Region of the British Gas Corporation is responsible for maintaining the safe and secure supply of gas from the National Transmission System to about two million customers. The gas supply system operated by the British Gas Corporation is based virtually 100% on North Sea resources. The Production and Supply Division of B.G.C. has the responsibility for transmitting the gas to the twelve regions of the Corporation.

The national scene is a complex one: some 140 thousand miles of pipelines and some 335 million therms of liquefied natural gas (L.N.G.) available each year to supplement the natural gas required by the regions.

The system must be able to meet the demand peaks as they occur, either by sizing all equipment to meet the maximum hourly rates, which can be extremely expensive, or by providing peak shaving facilities, which in the gas industry takes the form of gas storage. The peak load variation has a seasonal effect and an hourly effect.

British Gas meets seasonal demand variations by producing L.N.G. using surplus capacity available during the summer, storing this gas in well insulated refrigerated storage, and revapourizing the L.N.G. to meet high demand periods when available supplies of pipeline gas are insufficient to satisfy demand.

THE REGIONAL SCENE

The regions need to operate storage facilities in their areas to compensate for variations in gas demands due to consumers' habits and to compensate for day-by-day demand forecasting errors. Provision of new storage involves large capital costs and commits the industry to ongoing operating and maintenance costs. It is therefore essential that existing facilities are used to achieve the optimum benefit and the operational decision-making associated with its use is refined as far as possible.

British Gas have to balance out the national supply and demand for gas between the regions. It may be that in the future more gas will be held in national storage and distributed to the region requiring it. This would assist any region which had short-term storage or supply problems. Each year, North Thames Gas negotiate with British Gas H.Q. (B.G.C.) for quantities of gas or 'allocations' to be available for the next year. These allocations consist of a maximum daily rate of pipeline gas (called natural gas), a maximum daily rate of L.N.G. to supplement the pipeline gas on high demand days, and an annual volume of L.N.G. (see Figure 1). The staff in the regional control room have to use these resources to supply the gas demand efficiently.

DAILY GAS OPERATIONS

Each day the control room has to order from British Gas, or 'nominate', the amount of gas they will require to meet the forecast demand for the next day starting at 6 a.m. The...
nomination is made at 4 p.m. each day and revised at midnight when new temperature forecasts become available. These demand forecasts generally improve during the day as temperature forecasts become more accurate. The nominated amount of gas is normally taken at a flat rate during the day. To cope with the changes in the demand forecast, the control room staff can ask British Gas for ‘rate changes’ of natural gas and L.N.G. during the day. These changes are subject to certain time and size constraints (see Figure 2).

SIMULATION MODEL

The Operational Research Department has developed the Strategy Evaluation Program (S.E.P.) to aid decision making in these areas. S.E.P. uses historical temperature patterns and forecasts of future demand to simulate the operation of the gas supply system over some future period, usually one winter.

The FORTRAN program models the decisions made in the control room hour by hour, day by day and records information on the state of the system at hourly intervals.