Distribution Pipe:
Repair and Replacement Decision Manual

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# Contents

**INTRODUCTION**

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**SECTION 1 - BUDGET IMPLICATIONS**

*The System Management Approach to Repair/Replace Decisions* .................................................. 6
  1988 SIG BOYSEN, JR. Public Service Electric & Gas Company

*The Use of Decision Analysis and Risk Management to Optimize Expenditures* .......................... 19
  1996 DANIEL R. BAKER Consumers Power Company

*Risk Analysis in Distribution Design* .................................................................................................. 25
  1990 JAMES W. PETERS The Brooklyn Union Gas Company

*Gas Distribution Facilities Decision Making, Discussing An Asset Management Approach* ............. 30
  2005 GLYN HAZELDEN GTI

*A Risk Management Tool For Establishing Budget Priorities* .......................................................... 36
  1997 JOHN F. KIEFNER, Ph.D Kiefner and Associates, Inc.

*A Decision-Analytic Approach to the Replacement of Gas Mains and Services* .............................. 45
  2006 DAN O’NEILL O’Neill Management Consulting, LLC

**SECTION 2 - PRIORITIZATION METHODS**

*Task Group Report on Criteria for Replacement Versus Repair* .................................................... 50
  1969 AGA DISTRIBUTION DESIGN and DEVELOPMENT COMMITTEE

*Replacement Criteria for Cast-Iron Mains* ............................................................................................ 56
  1988 C. W. CROOKS, JR. Baltimore Gas & Electric Company

*Replacement Criteria for Steel Mains* .................................................................................................... 60
  1988 C. W. CROOKS, JR. Baltimore Gas & Electric

*Prioritizing and Making Replacement/Renewal Decisions on Gas Mains* ........................................ 64
  1988 MARK B. NELSON Northern States Power Company

*Leakage Control Through a Selective Gas Service Replacement Program* ........................................ 73
  1981 ANTHONY J. MORRISON Northeast Utilities Service Company

*The Pipeline Inspection and Maintenance Optimization System* ....................................................... 78
  1994 JOHN E. CONROY Woodward-Clyde Consultants

  RAM B. KULKARNI Woodward-Clyde Consultants

  THOMAS M. STEINBAUER Transmission Operations Research

*Cast Iron Main Break Predictive Models* .......................................................................................... 89
  1993 BERNADETTTE S. LOCHBAUM Public Service Electric and Gas Company

*A Bayesian Diagnostic Model for Pipeline Leak Prediction* .............................................................. 103
  1987 JUDY C. CHUANG, RAM B. KULKARNI and DINESH SHAH Woodward-Clyde Consultants

*Optimal Replacement Decisions for Cast Iron Gas Piping Systems* ............................................... 113
  1988 RAM B. KULKARNI Woodward Clyde Consultants

  KAMAL GOLABI Optima, Inc

  GEORGE DUGOVIC Rochester Gas and Electric Co

  KENNETH B. BURNHAM Gas Research Institute

*Comparison of CIMOS Results with Practice in a Large Distribution Company* ............................ 126
  1989 RAM B. KULKARNI Woodward-Clyde Consultants

*CIMOS Revisited* ................................................................................................................................. 129
  1995 DR. RENNY S. NORMAN Gas Research Institute

*Formal Decision Analysis Process Guides Maintenance Budgeting* .............................................. 133
  1994 DAN O’NEILL O’Neill Management Consulting, LLC

  K. L. ELENBAAS Consumers Power Co.

* From the 1990 Manual XL8920
SECTION 3 - REPAIR/REPLACEMENT ECONOMIC ANALYSIS
*Fundamentals of Repair/Replacement Analysis Under Group Depreciation ........................................ 139
  1989 GERALD G. WILSON Institute of Gas Technology
The EPOCH Concept: The Positive Impact Economics Can Have on the Integrity of a Distribution System ................................................................. 153
  1993 G. SHERI CONLEY Southern California Gas Company
*Repair Versus Replace Analysis-Guidelines for Existing Gas Mains .................................................. 166
  1987 THOMAS H. PADLEY, P.E. Iowa-Illinois Gas and Electric Company
Evaluating the Cost Effectiveness of Steel vs. Polyethylene Large Diameter Pipe .......................... 188
  1992 SIDNEY J. DAVIS Carnegie Natural Gas Company

SECTION 4 - APPLICATIONS OF REPAIR/REPLACEMENT DECISION MAKING
*Bare Steel Mains, Life and Economics ................................................................. 195
  1971 J. T. WELLENER Baltimore Gas and Electric Company
*Predicting Leaks and Optimizing Maintenance of Cast Iron Mains ........................................... 203
  1983 JAMES W. PETERS Brooklyn Union Gas
New Hampshire’s Bare Steel Replacement Program: An Example of Utility and Regulatory Cooperation ................................................................. 210
  2001 PAUL LaSHOTO Consultant
Managing Cast Iron Systems ........................................................................................................ 213
  1994 PETER COLLETTE Public Service Electric and Gas Company
Managing a Cast Iron System ........................................................................................................ 217
  1991 ROBERT J. MILLER The Brooklyn Union Gas Company

SECTION 5 - REHABILITATION
Creating A Pipeline Rehabilitation Plan ........................................................................................... 225
  1996 WILLIAM F. MARSHALL, P.E.
Rehabilitation Needs Assessment Procedures for Transmission Pipelines .................................. 236
  1993 HERBERT L. FLUHARTY, P.E. Mears/CPG, Inc.
  JOHN W. FLUHARTY, II Mears/CPG, Inc.
A Systematic Approach to Corrosion Problems of an Old Gas Distribution System ................. 246
  2006 MICHAEL P. DOLAN Consolidated Edison Company of New York (CECONY)

SECTION 6 - COMMERCIAL SOFTWARE AND REFERENCE RESOURCES
What to look for in Main Replacement and Risk-Assessment Software ................................... 253
  2003 GLYN HAZELDEN, P.E. Hazelden Group
Other Resources .......................................................................................................................... 261

INDEX OF AUTHORS .................................................................................................................. 262

INDEX OF SUBJECTS .................................................................................................................. 264

FORM FOR SUGGESTION TO CHANGE .............................................................................. 274

* From the 1990 Manual XL8920
DISTRIBUTION PIPE: REPAIR AND REPLACEMENT DECISION MANUAL

Introduction
Introduction

This technical report, which is a collection of industry papers and reference resources, provides an overview of the procedures and practices utilized to maximize the benefits received from gas distribution piping repair and replacement. Originally published in 1990 as “Attention Prioritizing and Pipe Replacement/Renewal Decisions,” AGA Catalog No. XL8920, 13 papers have been retained from this older manual and are identified in the Contents with an * and a footnote. The report was updated in 2006 by adding 18 additional papers for a new total of 31, and includes coverage of cast iron, steel, and, to a lesser extent, plastic gas distribution pipe infrastructure.

The basic issues associated with gas distribution repair and replacement expenditures are:

- Establishing annual maintenance and replacement budgets
- Establishing priorities for the sections of main that comprise a distribution system
- Evaluating the cost-effectiveness of whether a troublesome section should be repaired or replaced

These issues were covered in the original technical report and have been expanded on and updated in this current report. In addition, the 2006 report includes industry papers that address repair/replacement decision-making and pipeline rehabilitation, as well as commercial software and reference resources.

The papers and reference resources have been arranged into six sections. A synopsis of each section follows:

Section 1 - Budget Implications

The six papers in this section discuss various decision analysis techniques and programs used to optimize capital expenditures. The first paper, “The System Management Approach to Repair/Replace Decisions,” includes an approach to assessing the implications of various levels of replacement and repair of worn pipe in an existing system and relates the annual levels of repair and replacement to system performance. “Discussing An Asset Management Approach” describes how the Asset Management concept will facilitate risk management by improving system reliability while optimizing the allocation of financial resources. Other papers in this section address how to effectively allocate capital resources through defined cost-benefit analysis and risk management prioritization, such as “Gas Distribution Facilities Decision Making.”

Section 2- Prioritization Methods

Section 2 has twelve papers, including a 1969 AGA task group report, “Criteria for Replacement Versus Repair.” This report presents a concept for establishing a method, rather than presenting a detailed method of solution. The report includes: “Step I. Method to Establish Priority” and “Step II. Repair or Replace,” plus some example tables and forms that can be used. The next several papers, involve the use of a point system approach to establishing attention priorities for main sections. Point systems rank piping segments into groups, where application of risk reduction techniques will produce the greatest increase in system safety, the ultimate goal of the distribution integrity process. Certain papers, such as “Replacement Criteria For Cast Iron Mains,” address cast iron replacement while others, such as
“Replacement Criteria For Steel Mains,” address steel mains. For transmission pipe, one paper, "The Pipeline Inspection and Maintenance Optimization System," focuses on a tool to develop the optimum inspection and maintenance strategy. Also discussed in this section is CIMOS (Cast Iron Main Optimization System), a statistical approach based on a Bayesian diagnostic model and developed through research sponsored by the Gas Research Institute (GRI) beginning in 1984. A supporting paper in this section, “A Bayesian Diagnostic Model for Pipeline Leak Prediction,” describes the logic of a statistical procedure for predicting the probability of leaks for a distribution system or replacing a specified pipe segment. Another paper dealing with CIMOS, “CIMOS Revisited,” summarizes the use of the program by four gas companies.

**Section 3 - Repair Replacement Economic Analysis**

This section consists of four papers, with the first presenting a general procedure for analysis of repair/replacement economics. It includes discussion of the considerations that impact significantly on repair/replacement decision-making that are not easily reduced to monetary terms. Another paper employs the EPOCH (“Efficient Pipeline Operation in a Competitive Habitat”) concept, which considers past leak repairs as a general indicator of the mains condition, as well as the economic feasibility and risk associated with the decision to repair the main in lieu of replacing it. The third paper in this section, “Repair Versus Replace Analysis-Guidelines for Existing Gas Mains,” describes a repair/replacement decision process, which considers both economic and irreducible factors. The section concludes with a paper evaluating the cost-effectiveness of steel versus polyethylene large diameter pipe.

**Section 4 - Applications of Repair/Replacement Decision-making**

Section 4 consists of five papers, with the first, “Bare Steel Mains, Life, and Economics,” discussing an approach to repair/replacement economics for bare steel mains based on a breakeven graph. Another paper, “Predicting Leaks and Optimizing Maintenance of Cast Iron Mains,” describes a regression analysis model to predict the annual number of leaks for a cast iron pipe distribution system. It is also used to assess the effectiveness of a joint clamping program. The remaining papers in this section deal with managing cast-iron systems and bare steel replacement programs.

**Section 5 - Rehabilitation**

This section consists of three papers dealing with the rehabilitation of pipe and stresses how operators can make the most effective use of the rehabilitation dollar. These papers address the increasing need for today's pipeline operators to institute a program for the rehabilitation of their pipeline systems.

**Section 6 - Commercial Software and Reference Resources**

This final section provides a reference to some commercially available software designed and developed to support the decision process for main and pipeline repair/replacement expenditures. In each instance, the Web address of the software vendor current as of the time of publication is provided. In addition, this section lists valuable references that may be consulted to provide more information and guidance concerning the procedures and practices utilized to maximize the benefits received from piping repair and replacement expenditures.
The papers selected for inclusion in this technical report were chosen because they were either representative of the current state of the art or because they contained an approach or concept likely to be of use to others. Certain information in some papers is dated, but these papers are still thought to be of general value, which should be apparent in the context of the more recent papers. The combined information in them should give someone initiating a repair/replacement program a running start or facilitate revision and enhancement of an existing program.

No paper or procedures presented is necessarily the most effective for all distribution systems or more effective for a specific system than others not included. The operators of a system must apply considerable judgment based on knowledge of their system in selecting the prioritizing system and repair/replacement decision procedures to use.

Many of the papers used in this updated manual were given at an AGA Operations Conference and are identified with a reference such as (92-DT-7) or (95-OP-090). The first number is the year of the Operations Conference and the second number is a designation given to that specific paper. The reader should note that the information given in these older papers does not necessarily reflect processes, procedures and equipment now used by the companies. Also, please note that some of the older charts and tables are not of the quality we would prefer. Some have been retyped. However, it was not practical to re-type some of the more complicated charts and tables, and re-scanning was not helpful.

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Section 1
Budget Implications