Design of Water-Based FICE PROTECTION SUSTEMBLE SUSTEMBL

Robert M. Gagnon





DISK INCLUDED

Contents

Foreword	Xİİİ
Preface	XVİİ
About the Author	KİX
Acknowledgments	KXi
Introduction	XXIII
WHO SHOULD USE THIS BOOK/xxiii ■ HOW TO USE THIS BOOK/xxiii ■ BASIC MATHEMATICS REQUIRED FOR THIS BOOK/xxiii ■ Metric Conversions/xxiv ■ Metric Units/xxiv ■ SIGNIFICANT FIGURES AND ROUNDING/xxv ■ NFPA PUBLICATIONS/xxv ■ FIRE PROTECTION AS A PROFESSION/xxvi ■ FIRE PROTECTION TECHNICIANS AND ENGINEERS/xxvii ■ ORAL, WRITTEN, AND GRAPHIC COMMUNICATION/xxviii ■ GRAPHIC COMMUNICATION—DRAWING FIRE PROTECTION SYSTEMS/xxviii ■ The Blank Page/xxix ■ Drafting Equipment/xxx ■ Drawing Surface/xxx ■ Drawing Parallel Lines/xxxi ■ Scales/xxxi ■ Drawing Media/xxxii ■ Drawing Arrangement/xxxiii ■ Computer-Aided Design/xxxiv	
Contract Drawings	1
CONTRACT DRAWINGS COVER SHEET/2 ■ SITE DRAWINGS/3 ■ ARCHITECTURAL PLANS/8 ■ Building Sections/10 ■ Reflected Ceiling Plans/10 ■ Finish Schedule/12 ■ STRUCTURAL DRAWINGS/12 ■ Foundation Plans/12 ■ Framing Plans/12 ■ Branch Line Orientation/13 ■ Using Framing Plans to Dimension a Sprinkler System/13 ■ HVAC DRAWINGS/15 ■ PLUMBING DRAWINGS/17 ■ FIRE PROTECTION CONTRACT DRAWINGS/18 ■ ELECTRICAL DRAWINGS/19	
	About the Author Acknowledgments Introduction WHO SHOULD USE THIS BOOK/xxiii ■ HOW TO USE THIS BOOK/xxiii ■ BASIC MATHEMATICS REQUIRED FOR THIS BOOK/xxiii ■ Metric Conversions/xxiv ■ Metric Units/xxiv ■ SIGNIFICANT FIGURES AND ROUNDING/xxv ■ NFPA PUBLICATIONS/xxv ■ FIRE PROTECTION AS A PROFESSION/xxvi ■ FIRE PROTECTION TECHNICIANS AND ENGINEERS/xxvii ■ ORAL, WRITTEN, AND GRAPHIC COMMUNICATION/xxviii ■ GRAPHIC COMMUNICATION—DRAWING FIRE PROTECTION SYSTEMS/xxviii ■ The Blank Page/xxix ■ Drafting Equipment/xxx ■ Drawing Surface/xxx ■ Drawing Parallel Lines/xxxi ■ Scales/xxxi ■ Drawing Media/xxxii ■ Drawing Arrangement/xxxiii ■ Computer-Aided Design/xxxiv Contract Drawings CONTRACT DRAWINGS COVER SHEET/2 ■ SITE DRAWINGS/3 ■ ARCHITECTURAL PLANS/8 ■ Building Sections/10 ■ Reflected Ceiling Plans/10 ■ Finish Schedule/12 ■ STRUCTURAL DRAWINGS/12 ■ Foundation Plans/12 ■ Framing Plans/12 ■ Branch Line Orientation/13 ■ Using Framing Plans to Dimension a Sprinkler System/13 ■ HVAC DRAWINGS/15 ■ PLUMBING DRAWINGS/17 ■ FIRE PROTECTION CONTRACT DRAWINGS/18 ■ ELECTRICAL

Chapter 2	Contract Specifications	23
	SPECIFICATION TYPES/24 ■ Computer Specification Database/24 ■ Performance Specifications and Detailed Specifications/24 ■ SPECIFICATION FORMAT/25 ■ Division 0: Instructions to Bidders/26 ■ Division 1: General Requirements/26 ■ Division 2: Site Work/26 ■ Divisions 3–6: Concrete, Masonry, Metals. and Wood and Plaster/26 ■ Division 7: Thermal and Moisture Protection/27 ■ Divisions 8 and 9: Doors and Windows, and Finishes/27 ■ Divisions 10–12, 14: Specialties, Equipment, Furnishings, and Conveying Systems/27 ■ Division 13: Special Construction/27 ■ Division 15: Mechanical/28 ■ Division 16: Electrical/29 ■ SAMPLE SPECIFICATION/29	
Chapter 3	Fire Protection Survey Procedure	35
	GET YOUR BEARINGS/36 ■ DETERMINE THE GENERAL BUILDING LAYOUT/36 ■ BRING PROPER SURVEY EQUIPMENT/37 ■ SURVEY BUILDING DETAILS/38 ■ DEVELOP A SYSTEM DESIGN STRATECY/39 ■ Building Elevations/39 ■ Ceiling Measurements/39 ■ Water Supply Information/40 ■ DRAW THE BUILDING AND LAY OUT THE SYSTEM/40 ■ FIELD CHECK THE DRAWING/40 ■ INSPECT THE SYSTEM AFTER INSTALLATION/41	
Chapter 4	Underground Piping Design Procedure	43
	OBTAIN REFERENCE MATERIAL AND TRACE OR SCAN BACKGROUND/45 ■ DETERMINE PIPE ROUTING/46 ■ DRAW CUT-IN DETAIL/47 ■ ADD INVERT PIPING ELEVATIONS AND PLAN DIMENSIONS/47 ■ SPECIFY PIPING AND FITTINGS/50 ■ DETAIL THRUST BLOCKS AND PIPING RESTRAINTS/51 ■ DETAIL LOCATIONS OF FIRE HYDRANTS/52 ■ PERFORM A WATER FLOW TEST/53 ■ Flow Test Tools/56 ■ Flow Test Protocol/56 ■ Flow Test Procedure/57 ■ DETAIL WATER SUPPLY INFORMATION ON PLANS/65	
Chapter 5	Automatic Sprinkler Systems	70
	SPRINKLER SYSTEMS—MYTH VERSUS FACT/71 ■ STANDARDIZED AUTOMATIC SPRINKLER SYSTEM DESIGN/72 ■ SPRINKLER SYSTEM DEFINITIONS/73 ■ "Approved" versus "Listed"/73 ■ "Shall" versus "Should"/73 ■ "Fire Control" versus "Fire Suppression"/74 ■ SPRINKLER TYPES/74 ■ Old Style and Spray Sprinklers/74 ■ Upright, Pendent, and Sidewall Sprinklers/75 ■ Sprinkler Coverage/75 ■ Sprinkler Response/75	

■ Sprinklers for Storage Applications/78 ■ SPRINKLER SYSTEM TYPES/78 ■ Wet Pipe Systems/78 ■ Dry Pipe Systems/78 ■ Preaction and Deluge Systems/79 ■ SPRINKLER SYSTEM COMPONENTS/81 ■ Sprinklers/81 ■ Piping and Tubing/82 ■ Fittings/82 ■ Hangers/84 ■ Valves/84 ■ DEVELOPING A SPRINKLER PLAN FOR APPROVAL/87 ■ Collect and Review Data/88 ■ Review Project Schedule/88 ■ Trace or Scan Building Outline/89 ■ Draw Necessary Building Detail/90 ■ Determine Branch Line Logic/91 ■ Determine System Type and Configuration/93 ■ Determine the Hazard Class of the Occupancy/95 Determine the Area Protected by Each Sprinkler (A)/96 ■ Determine the Number of Branch Lines/98 ■ Determine the Distance between Branch Lines (L)/100 ■ Determine the Maximum Allowable Distance between Sprinklers (S)/100 ■ Determine the Minimum Number of Sprinklers on Each Branch Line/101 ■ Determine the Actual Distance between Sprinklers $(S_{\text{actual}})/102$

Dimension Sprinklers and Piping on Your Drawing/102 ■ Verify Sprinkler Coverage/102 ■ Determine Crossmain Location/103 ■ Assign Elevations to Piping/104 ■ Locate System Risers/105 ■ Select Hangers and Determine Hanger Rod Lengths/105 ■ Determine Hanger Spacing/106 ■ Add Final Details/108 ■ Use the NFPA 13 Design Checklist/109 ■ Perform Precalculation Field Check/109 ■ Add Pipe Lengths and Verify Accuracy/109

Chapter 6 Hydraulic Calculation of Sprinkler Systems

THE FUNDAMENTALS OF HYDRAULICS/115 ■ The Advantages of Water/115 ■ The Properties of Water/116 ■ Hydrostatics/120 ■ Hydrokinetics/123 ■ Friction Loss/126 ■ Friction Loss Tables/128 ■ Reducing Friction Loss/129 ■ Friction Loss in Simple Pipe Loops/129 ■ Friction Loss in Simple Loops— Equivalent Length/132
Analysis of Loop Calculation Results/136 ■ HYDRAULIC CALCULATION METHOD FOR SPRINKLER SYSTEMS/137 ■ Hand Calculations versus Computer Calculations/137 ■ Choosing the Hydraulically Most Demanding Area/138 ■ Hydraulic Calculations—Selection of Occupancy/138 ■ Selecting a Hydraulic Density/139 ■ Determining the Length of the Design Area/142 ■ Number of Sprinklers Flowing along the Length of the Design Area/143 ■ Configuration of Sprinklers in the Design Area/145 ■ Minimum Flow at the Hydraulically Most Demanding Sprinkler/146 ■ Determining the Minimum Pressure at the Hydraulically Most Demanding Sprinkler/146 Determining Friction Loss/147 ■ An Example Calculation/148 ■

	Calculations for Approval/157 Velocity Pressure Calculations/157 Quick Response Sprinklers and the Design Area/158 Extended Coverage Sprinklers and the Design Area/159 COMPUTERIZED HYDRAULIC CALCULATION PROGRAMS/160 Use of the Computerized Hydraulic Program Included in This Book/160	
Chapter 7	Specialized Piping and Calculation Methods	163
	PIPE SCHEDULE DESIGNS/164 ■ RESIDENTIAL SPRINKLER SYSTEMS/165 ■ One- and Two-Family Dwellings and Manufactured Homes/165 ■ Residential Occupancies up to and Including Four Stories/173 ■ Residential Occupancies Greater Than Four Stories/173 ■ Freeze Protection for Residential Sprinkler Systems/173 ■ SPRINKLER PROTECTION OF HIGH- PILED STORAGE OCCUPANCIES/176 ■ ESFR Sprinklers/179 ■ STANDPIPE AND HOSE SYSTEMS/179 ■ FIRE PUMPS/182 ■ Fire Pump Components/183 ■ Calculating Pressure Differentials/184 ■ When to Add a Fire Pump/186 ■ Graphing a Fire Pump Supply/186 ■ Combining a Pump and City Supply/187 ■ Sizing a Fire Pump/188 ■ GRAVITY TANKS/189 ■ Gravity Tank Calculation/189 ■ Graphing a Gravity Tank Supply/190	
Chapter 8	Water Spray System Design for Transformers	193
	WATER SPRAY SYSTEMS/194 ■ Water Spray Protection for a Power-Generating Plant/194 ■ The Rankine Cycle/196 ■ WATER SPRAY PROTECTION FOR TRANSFORMERS/197 ■ Transformer Hazards/197 ■ Personnel and Other Hazards/198 ■ Power Generation/198 ■ Oil Recovery and Reclamation/198 ■ Extinguishment/Control Mechanism/198 ■ TRANSFORMER DESIGN PROCEDURE/200 ■ Compile Reference Data/200 ■ Commence Layout/202 ■ Transformer Loop Design/204 ■ Calculation of Transformer Surface Area/206 ■ Water Spray for Nonabsorbing Ground Surfaces/208 ■ Recommendations for Water Spray System Layout/209 ■ Hydraulic Calculation Procedure for Transformers/213 ■ Detection Systems/217	
Chapter 9	Water Spray System Design for Flammable Liquid Storage Tanks or Vessels	224
	HAZARDS ASSOCIATED WITH TANKS AND VESSELS/225 ■ Piloted and Autoignition/225 ■ Pool Fire	

Containment/225 ■ Pressure Spray Fires/225 ■ Deflagration and

Rupture/226 ■ VESSEL PROTECTION MECHANISMS/226 ■ Exposure Protection/226 ■ Surface Cooling/227 ■ Rundown/227 ■ Prevention of Boiling Contents/227 ■ Supplementary Protection for Vessels/229 ■ VESSEL WATER SPRAY DESIGN PROCEDURE/230 ■ Surface Area Calculation/230 ■ Estimating the Minimum Water Supply Requirement/231 ■ Total Water Requirement/232 ■ Estimation of Water Supply Adequacy/232 ■ Pressure Estimation/233 ■ Loop and Nozzle Spacing Procedure/234	
Ultra High Speed Water Spray Systems	246
Definition/247 ■ Ultra High Speed Water Spray Systems and Explosion Suppression Systems/247 ■ Why Water?/248 ■ Deflagrations and Detonations/249 ■ Uses for Ultra High Speed Water Spray Systems/249 ■ Reaction Time/249 ■ Human Senses/249 ■ Detectors for Ultra High Speed Water Spray Systems/250 ■ Design Approaches/250 ■ Types of Ultra High Speed Water Spray Systems/250 ■ THE SQUIB-ACTUATED ULTRA HIGH SPEED WATER SPRAY SYSTEM/252 ■ Definition/252 ■ Preprimed Piping System/252 ■ The Squib-Actuated Valve/253 ■ System Response Time/254 ■ Squib-Actuated Ultra High Speed Water Spray System Design/255 ■ THE SOLENOID-OPERATED ULTRA HIGH SPEED WATER SPRAY SYSTEM/255 ■ System Arrangement/255 ■ The Discharge System/255 ■ The Pilot System/256 ■ Sequence of Operation for a Pilot-Actuated System/258 ■ Factors Influencing the Speed of a Pilot-Actuated System/260 ■ Response Time for Solenoid-Operated Systems/260	
Water Mist System Design	262
WATER MIST PERFORMANCE OBJECTIVES/263 ■ WATER MIST DROPLETS/263 ■ Droplet Size/263 ■ Droplet Size Performance Objectives/265 ■ Droplet Size and the Fire Service/265 ■ Measuring Droplet Size/266 ■ Water Mist Pressure and Droplet Size/266 ■ WATER MIST SYSTEM DESIGN/267 ■ Water Mist System Types/267 ■ Water Mist System Calculation Criteria/268 ■ WATER MIST APPLICATIONS/268 ■ Submarine Applications/269 ■ Surface Ship Applications/270 ■ Aircraft Applications/271 ■ Total Flooding Electronics and Telecommunications Applications/272 ■ Commercial and Residential Applications/273	

Chapter 10

Chapter 11

Chapter 12	Quality Assurance and Coordination	279
	QUALITY ASSURANCE PROCEDURES/280 ■ Quality Assurance Review/280 ■ COORDINATION/281 ■ Scheduling the Coordination Process/282 ■ Prefabrication of Fire Protection Systems/282 ■ The Coordination Meeting/283 ■ Sanctioning a Coordination Meeting/283 ■ Coordination Negotiations/284 ■ Putting the Coordination Agreements into Action/284 ■ Coordination Failures/285 ■ Coordination Drawings/285 ■ The Value of Coordination/286	
Chapter 13	Ethics and Professional Development	288
	GOOD VERSUS EVIL/289 ■ The Ethical Dilemma/289 ■ RESPONSIBILITIES OF A FIRE PROTECTION PROFESSIONAL/290 ■ Personal Values/290 ■ Company Values/290 ■ Societal Values/291 ■ Values of the Client/292 ■ Values of the Fire Protection Profession/293 ■ PROFESSIONAL STANDARDS OF CONDUCT/293 ■ Code of Responsibility for NICET-Certified Engineering Technicians and Technologists/293 ■ The Code of Ethics for Engineers/297 ■ The Profession of Engineering/298 ■ LEGAL/ETHICAL CONFLICTS/299 ■ RESOLVING ETHICAL DILEMMAS/299 ■ Rationalization/299 ■ Whistle-Blowing/300 ■ RESPONSIBILITIES OF A STUDENT/301 ■ RESPONSIBILITIES OF A PROFESSIONAL/301 ■ Professional Development/301	
Appendix A	Reference Tables	307
Appendix B	c-Factors	324
Appendix C	Pipe Diameters	326
Appendix D	Friction Loss Tables	528
Appendix E	Computerized Hydraulic Program Documentation	415
Appendix F	Selected NFPA Standards	436
	Acronyms	439
	Glossary	441
	Additional Readings	449
	index	454