

Contents

Page

Foreword	vii
9.6.6 Rotodynamic pumps for pump piping	1
9.6.6.1 Scope	1
9.6.6.2 Introduction	1
9.6.6.3 Inlet (suction) piping requirements	2
9.6.6.3.1 Inlet (suction) pipe size/velocity requirements	2
9.6.6.3.2 Effect of piping-generated swirl	3
9.6.6.3.3 Required straight pipe lengths	3
9.6.6.3.4 Need for physical hydraulic model study	11
9.6.6.3.5 Use of computational fluid dynamics (CFD)	11
9.6.6.3.5.1 General	11
9.6.6.3.5.2 Simulation methods	11
9.6.6.3.5.3 Acceptable use of CFD modeling in pump suction hydraulics	13
9.6.6.3.6 Pump suction piping/wet-well connection	13
9.6.6.3.7 Pump suction elbows	13
9.6.6.3.8 Pump station retrofit or modification	14
9.6.6.4 Outlet (discharge) piping requirements	14
9.6.6.4.1 Pipe size/velocity requirements	14
9.6.6.4.2 Required straight pipe lengths	15
9.6.6.4.3 Recommended valves	15
9.6.6.4.4 Water hammer	16
9.6.6.5 Inlet and outlet general piping requirements	16
9.6.6.5.1 Pipe nozzle alignment/pipe expansion load	16
9.6.6.5.1.1 Pump nozzle flange analysis	17
9.6.6.5.2 Pipe supports/anchors	17
9.6.6.5.2.1 Design considerations	18
9.6.6.5.2.2 Cold spring	18
9.6.6.5.2.3 Final installation	18
9.6.6.5.2.4 Field adjustment	18
9.6.6.5.3 Parallel operation	18
9.6.6.6 References	21
9.6.6.7 Sources of additional information	22
9.6.6.8 List of acronyms	22
Appendix A System curves	24
A.1 Calculation of the system curve	24
A.2 Pipe head loss calculation methods	26
Appendix B Water hammer	28
B.1 Water hammer	28

Appendix C	Selecting and locating pipe supports and restraints	32
C.1	Restraint and stops	32
C.2	Pipe supports for vertical loads	32
C.3	Guides and restraints	34
C.4	True anchors	34
C.5	Spring supports	34
C.6	Friction from supports	35
Appendix D	Expansion joints and couplings	36
D.1	Expansion joint types	36
D.2	Expansion joint application	38
Appendix E	Specialty piping components and applications	40
E.1	Check valves and strainers	40
E.2	Devices to improve flow to the pump	41
E.3	Piping for suction lift applications	42
E.4	Solids/slurry	43
E.5	Air release valves	44
Appendix F	Pressure pulsation and acoustic resonance	45
F.1	General	45
F.2	Outlet (discharge) piping acoustics	45
Appendix G	Index	47
Figures		
9.6.6.3	— Suction pipe design	2
9.6.6.3.3a	— General example – pump suction with a required L_2 length from a flow-disturbing fitting	5
9.6.6.3.3b	— General example – pump suction with an allowed fitting connected directly and a required L_2 length from a flow-disturbing fitting	6
9.6.6.3.3c	— Specific example – horizontal overhung pump suction with a required L_2 length from a short-radius reducing elbow (< 30% area reduction)	6
9.6.6.3.3d	— Specific example – horizontal overhung pump suction with a concentric reducer (1 pipe size reduction), and a required L_2 length from a short-radius elbow	7
9.6.6.3.3e	— Specific example – between bearing split case pump suction with a required L_2 length from a suction header	7
9.6.6.3.3f	— Specific example – between bearing split case pump suction with an eccentric reducer (1 pipe size reduction), a required L_2 length from a concentric reducer (3 pipe size reduction), and a short-radius elbow	8
9.6.6.3.3g	— Specific example – horizontal overhung pump suction with a required L_2 length from a concentric reducer (4 pipe size reduction) and a long-radius elbow	8
9.6.6.3.3h	— Specific example – vertical overhung pump suction with a manufacturer-approved 90° elbow, an eccentric reducer (1 pipe size reduction), and a required L_2 length from a long-radius elbow	9
9.6.6.3.3i	— Specific example – vertical overhung pump suction with a manufacturer-approved 90° elbow and a required L_2 length from a concentric reducer (4 pipe size reduction)	9
9.6.6.3.3j	— Specific example (top view) – between bearing split case pump suction with an eccentric reducer (1 pipe size reduction), a required L_2 length from a concentric reducer (3 pipe size reduction), and a short-radius elbow	10

9.6.6.3.3k — Undesirable effect of a horizontal elbow mounted directly on suction flange	10
9.6.6.3.3l — Examples of suction pipe fittings near the pump that require approval of the pump manufacturer	12
9.6.6.4.3 — Triple-duty valve	15
9.6.6.5.3a — Parallel pump installation	19
9.6.6.5.3b — Constant-velocity manifold design, parallel pumps	20
9.6.6.5.3c — Minimum required suction line length and spacing for parallel pumps	20
9.6.6.5.3d — Improved pipe fitting connection alternative with a weld saddle, reducing tee, or a tee with a reducer	21
C.1 — Pipe supports for vertical loads.	33
C.2 — Solid pipe hanger supports	33
C.3 — Constant-effort spring supports	33
C.4 — Pipe guides	34
C.5 — Spring supports.	35
D.1 — Slip/packing expansion joint	36
D.2 — Rubber expansion joints	37
D.3 — Metal bellows expansion joint.	37
D.4 — Expansion joint bolting arrangement	38
E.1 — Foot valve	41
E.2 — Typical temporary strainer	41
E.3 — Second upstream perpendicular elbow	42
E.4 — Self-priming bypass	43
Tables	
9.6.6.3.2 — Minimum required straight pipe length (L_2) before pump suction inlet	4
B.1 — Magnitude of pressure wave.	31