CONTENTS

Abstract …….. **i**

List of Figures ….……..... **iii**

List of Tables …… …….……. **iv**

List of Abbreviations…… **v**

List of Symbols…… …… **vii**

1. Introduction…….. **1**

Introduction to water sector and canal Automation ……. . 1

2. Analysis of Present Schemes…… **9**

2.1 Pilot Project for Dynamic Regulation at Mazalgaon …… 9

2.1.1 MASTER CONTROL CENTER (MCC) (Parli-Vaijnath)…… 10

2.1.2 HEAD REGULATOR at MAZALGAON DAM……. 11

2.1.3 Ganga Masla Branch Canal (GMBC)…… 12

2.1.4 First Field Station…….. …. 13

2.1.5 Third Field Station…….……. 14

2.1.6 Staff …….…….. 14

2.2 Khadkwasala Canal Automation System…….….. 14

2.2.1 Khadkwasala Dam Site…….……14

2.2.2 Master Control Center (MCC) - Sinchan Bhavan, Pune …....…. 15

2.2.3 AGROMET Station at Yawat……..…. 15

2.2.4 Cross Regulator at KM 72……..... 16

2.2.5Motorized Control Gate System…….…..... 16

2.3 Rajghat Canal System…….…… 17

2.4 Vinukonda Canal Automation Scheme…….. 20

2.5 Tungabhadra Canal Automation Scheme……... 21

2.6Indira Gandhi Nehar Pariyojana (IGNP)…… 21

3. Flow Measurements & Communication System …… **29**

3. 1Measurements of Canal Flow …….. 29

3.1.1Stage Discharge by Level Measurement …… 29
3.1.2 Current Meters Measurement……... 30
3.1.3 Measurement by Flumes……... 30
3.1.4 Upstream, Downstream Levels with Gate Openings…… 32
3.1.5 Ultrasonic Transit Time Flow Measurements……... 33
3.1.6On-Line Acoustic Doppler Current Profiler (OADCP)……..... 35
3.1.7 Radar Flow Measurements ……..... 36

3.2 Communication ……..… 38
3.2.1 Wired or Line Communication …….…..... 40
3.2.2 Wireless Communication …….……. 41
3.2.2.1- UHF/VHF Communication …….…… 41
3.2.2.2 Global System for Mobile Communication …….. 44
3.2.2.3 Satellite Communication ……..... 45
3.2.2.3.1 VSAT (Very Small Aperture Transmission)
Communication …….....45 3.2.2.3.2INSAT
(Indian National Satellite System)
Communication …….....48
3.2.4 Microwave Communication……..... 49

4 Control Philosophies ……... 53
4.1 Downstream Level Control ……. 54
4.2 Upstream Level Control …….. 55
4.3 Constant Volume Control …….…... 56
4.4 Controlled Volume Control (Dynamic Operation) …….…… 57
4.4.1 General Control Concepts……..... 61
4.4.2 Control Logic …….……. 63
4.4.3 Flow Correction …….……. 63
4.4.4 Pole Placement Controller Design…….……... 64
4.4.5 The P+PR (Proportional + Preoperational Reset)
Controller Design ……..... 65
4.4.6. Regulation Software Formulae……..... 65
4.4.6.1 Volume Assessment …….…….. 65
4.4.6.2 Volume Calculations……65

4.4.6.3 Transiting Discharge …….....66
4.4.6.4 Determination of Correction Discharge …….67
4.4.7 Regulation Software …….....68
4.4.7.1 Software System ……69
4.4.8 Regulation Interface ……70
4.4.9 Exceptional Operation …….. 72

5 SCADA & Power Supply …… 75

5.1 SCADA: Supervisory Control and Data Acquisition ……. 75
5.2 Power Supply ……... 77
5.2.1 Mains Electricity ……..…….. 77
5.2.2Diesel Generators ……..78
5.2.3 Solar Power..... 79
5.2.3.1 Load Calculations ……. 79
5.2.3.2 Solar Panel Calculations……. 80
5.2.3.3 Battery Calculations……... 80
5.2.4Wind Power …….……. 80
5.2.5Hybrid Power …….……... 80
5.2.6 Hydro Power at Cross Regulator ……..…… 81

6 Conclusions, Field Work & Future Scope …… 82

6.1. General …… 83
6.2. Measurements …….. 86
6.3. Communication ……..... 87
6.4. Power Supply ……... 88
6.5. SCADA, Computers & Displays ……. 88
6.6. Instrumentation and System ……..... 89
6.7. Installation & Maintenance of the System…… 90
6.8. Training to Staff……... 90
6.9. Contribution of the Researcher at Field Work ……... 90

References …… 101

List of Publications …….. 108

List of patents ……... 111