Best Practice Guide to Commissioning a Piped Irrigation System
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Commissioning purpose</td>
<td>1</td>
</tr>
<tr>
<td>Structure of this manual</td>
<td>3</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>3</td>
</tr>
<tr>
<td>1. Commissioning process</td>
<td>4</td>
</tr>
<tr>
<td>1.1 Commissioning plan</td>
<td>6</td>
</tr>
<tr>
<td>2. Commissioning documents</td>
<td>11</td>
</tr>
<tr>
<td>3. Training</td>
<td>14</td>
</tr>
<tr>
<td>4. Flushing</td>
<td>14</td>
</tr>
<tr>
<td>Appendices</td>
<td>15</td>
</tr>
<tr>
<td>Appendix 1: Commissioning process</td>
<td>15</td>
</tr>
<tr>
<td>Appendix 2: Pump station commissioning checklist</td>
<td>19</td>
</tr>
<tr>
<td>Appendix 3: Example as-built plans</td>
<td>20</td>
</tr>
</tbody>
</table>

Date of Issue: TBC  
Revision: TBC 2016  
Address for comments: 'Best Practice Guide to Commissioning a Piped Irrigation System'  
Irrigation New Zealand  
PO Box 69119  
Lincoln  
Christchurch  
www.irrigationnz.co.nz  
ISBN Numbers:  
Printed: TBC  
PDF: TBC  
© Irrigation New Zealand 2013  
Supported by Sustainable Farming Fund
Introduction

Rapid irrigation development has taken place in New Zealand, particularly in the last two decades, with increasing levels of investment in irrigation systems and irrigation research. In general, irrigation has been highly successful and has driven agricultural intensification in the drier areas, improving and sustaining the general well-being of rural communities.

However, some irrigation systems have under-performed in economic terms, and independent irrigation audits have highlighted shortcomings in irrigation system design and management. Reasons for this include:

- Poor understanding of client priorities and needs
- Unrealistic expectations by the owners at the system proposal stage
- Capital cost over-runs due to poor contract control
- Substandard design and installation
- Poor system start up and commissioning procedures prior to handover to owners and operators
- Poor irrigation system management and service provisions.

It is important that all systems regardless of complexity and size are commissioned.

In addition, water regulators (regional councils), government agencies, the agricultural community and the general public have lifted their expectations for better responses by irrigators to potential adverse effects of irrigation on water quantity and quality. Increasing pressure is being placed on irrigation system owners to lift the level of environmental performance whilst still maintaining economic and affordable productivity.

Irrigation New Zealand, in consultation with its Technical and Trade stakeholders as part of its mission to promote excellence in irrigation, has initiated the development and review of this irrigation Commissioning and As-Built Manual.

Commissioning purpose

Commissioning is a process by which agreement is reached that the installed system meets the design performance specifications. It verifies that the system is complete to the required workmanship standards, is safe to operate and is ready to perform as per the designer’s and operator’s system performance expectations. The base line as-built Key Performance Indicators (KPIs) are determined and can subsequently be used as a reference point for future condition and performance assessment of the irrigation system.

Commissioning occurs at the substantial completion of the installation contract and as the first transition into the operational period. The contract should be clear on when the ownership and responsibility changes from the installer to the owner and whether any defect periods comes into force that requires the installer or designer to maintain control obligations. In most cases the commissioning is the point in time when responsibility for the system is handed over from the designer and installer to the owner/operator and may have implications for insurances, maintenance programmes and consent compliance.

This Commissioning and As-Built Manual provides a consistent practice guide for designers, installers and operators of piped agricultural irrigation systems in New Zealand. It includes a general commissioning plan and as-built drawing approach with specific items that must be considered when planning, designing, and implementing a new irrigation development.
This manual provides guidelines to undertake the commissioning of simple to complex on-farm piped irrigation projects. It ensures that all of the main testing, start-up, commissioning and handover aspects of the irrigation development have been considered. It includes the following components:

- electricity/diesel power supply and associated control equipment
- motor and pump
- headworks
- monitoring, data logging and telemetry equipment
- distribution network
- water application equipment.

It is expected that designers, installers and operators will follow the general processes outlined in this manual, but many will have their own specific procedures and interpret it according to the requirements of individual properties and system types. All decisions made must comply with statutes, regulations, and other legal requirements and industry standards.

In the context of this document it is assumed any reference to the operator means the owner, their operational staff or the owner’s agreed representative for completion acceptance within the INZ Standard contract agreement.

The manual is part of a suite of Irrigation New Zealand documents to be used in conjunction with one another. The other documents include:

- The New Zealand Piped Irrigation Systems Design Code of Practice (INZ, 2013)
- The New Zealand Piped Irrigation Systems Design Standards (INZ, 2013)
- The New Zealand Piped Irrigation Systems Installation Code of Practice (INZ, 2012)
- The Standard Irrigation Contract (INZ, 2013)
- The New Zealand Piped Irrigation Systems Performance Assessment Code of Practice (INZ, 2014)
- Irrigation development checklist (INZ, 2013)

The Commissioning and As-Built Manual applies only to piped irrigation systems. It does not cover:

- Surface water irrigation methods
- Surface water structures (e.g. races or ponds)
- Irrigation equipment manufacturing or quality standards
- Installation of irrigation systems
- Performance assessment of irrigation systems.

Those activities should be guided by the relevant existing codes of practice.

This Commissioning and As-Built Manual does not amend or replace other industry, performance indicators, guidelines, codes of practice and standards; or provide sufficient information for designers, installers or owners intending to work outside of their current area of expertise.
Structure of this manual

This manual is provided to show the designer how a commissioning plan document should be prepared for the installer and what information should be included to satisfy the operator.

This manual contains key sections:

- Commissioning process
- Commissioning Plan
- Commissioning documents.

Acknowledgements

Organisations, individuals and stakeholders contributing to the preparation of this Commissioning and As-Built Manual include:

- Irrigation New Zealand
- Opus International Consultants Ltd
- INZ Technical and Trade stakeholders review process at industry meetings, who willingly provided advice.

Financial support for preparation of the Code of Practice has been provided by:

- Ministry of Primary Industries (Irrigation Acceleration Fund)
- Irrigation New Zealand.
1. Commissioning process

The following sequence of steps is suggested:

• Set up commissioning expectations in contract
• Put together a suitably qualified and experienced commissioning team.
• Draw up commissioning plan
• Collect pre commissioning documentation
• Undertake pre commissioning checks
• Undertake commissioning – appendix 1
• Sign off.

The critical starting information needed includes:

A. System Constraints (what will be tested)
   — system description (including operational and control philosophy descriptions);
   — flow, pressure and other KPIs according to the agreed performance criteria set out in the contract
   — limits for high, low and normal operation;
   — limits for failed operation and emergency response;
   — safety provisions;
   — Monitoring and telemetry
   — environmental protection.

B. Contractual information needed to manage the commissioning exercises includes, with reference to the contract provisions:
   — Budget (if additional to the Installer’s price);
   — timetable, including milestones and hold points if necessary for large systems being commissioned in sub-sections;
   — roles for each party;
   — quality control to ensure outputs and reports are valid and acceptable to the parties;
   — documentation and reporting procedures, including as built plans required.

C. A communications plan that identifies key participants and responsibilities.

Once this information is assembled, a start-up and commissioning plan can be written that identifies timetables, procedures, measurable performance requirements and acceptance criteria as well as process or method.

The commissioning exercise involves a start-up (of components, sub-systems and systems) that is well planned and executed, followed by the commissioning of the overall systems that secures appropriate confidence in the system performance to meet overall expectations.
The following table outlines the components and phases within the commissioning process.

<table>
<thead>
<tr>
<th>Sub systems</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Equipment testing</td>
<td>b. Sub sytems start up</td>
<td>Commissioning, whole system run up</td>
</tr>
<tr>
<td><strong>water source</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>n/a</td>
<td>check functional</td>
<td>verify functional</td>
</tr>
<tr>
<td>Pumps</td>
<td>check all electrical check rotation “bump test”</td>
<td>dead head test cut outs and alarms VSD and SS setup</td>
<td>verify flow/heat/power across whole process range including extremes</td>
</tr>
<tr>
<td>Filter</td>
<td>check all electrical</td>
<td>check functions check flush discharge set up controller</td>
<td>verify functional</td>
</tr>
<tr>
<td>Automation</td>
<td>electrical test</td>
<td>set up initial programme</td>
<td>verify settings check emergency stop/start</td>
</tr>
<tr>
<td>Backflow</td>
<td>check install</td>
<td>check functional</td>
<td>verify functional</td>
</tr>
<tr>
<td>Headworks pressure / Flow control</td>
<td>check install</td>
<td>set up valves control</td>
<td>refine valve settings</td>
</tr>
<tr>
<td>Distribution network</td>
<td>pipe pressure test, leak and joint inspections</td>
<td>produce overall systems as-built drawings</td>
<td>leak and joint inspections</td>
</tr>
<tr>
<td>Field valving</td>
<td>check install</td>
<td>test control signals set up pilots</td>
<td>check and balance settings</td>
</tr>
<tr>
<td>Emitters</td>
<td>check install</td>
<td>equipment specific checks, set up pivots, guns etc</td>
<td>full field evaluation use CoP Evaluation to check against the contractual KPIs</td>
</tr>
<tr>
<td>Monitoring</td>
<td>check install</td>
<td>set up monitoring and instrumentation</td>
<td>verify functional</td>
</tr>
<tr>
<td>Flushing/cleaning</td>
<td>clear pipelines</td>
<td>check auto flushing systems</td>
<td>verify functional</td>
</tr>
</tbody>
</table>

Output is test report and certificates of compliance as-built drawings.

Output is commissioning report.

Output is maintenance and compliance report.
1.1 Commissioning plan

GOALS
The goal of the commissioning plan for the project includes:

- Completion of a well-documented operational system
- Undertaking a well-planned and complete commissioning service that examines full operating ranges of the system to ensure compliant functioning of all systems and sub-systems
- Minimising start-up failures and replacements
- Clarifying hand over from installer to operator.

CONSTRAINTS
Constraints to meeting these objectives include:

- Time and scheduling
- Budget and contingencies
- Pre-test and pre-run competency prior to commissioning work
- Weather
- Cooperation and availability of participants and technical support
- Completeness of commissioning plan and pre-preparation of test program
- Safety
- Existing operation (maintenance of).

OUTLINE
A commissioning plan should include the following

- Scope
- Who is involved
- Responsibilities
- Timelines
- Quality control
- Sub-systems
- Budget
- Communications plan
- Administrative needs
- Outputs.

1. SCOPE
The scope of the commissioning plan should be a statement of the overall expectations of the plan together with a description of the disciplines to be included in the commissioning work. The work should be broken down into the key components and the interfaces of the components should be identified. Reference documents such as flow diagrams, parts lists, construction drawings, etc. should be identified. The commissioning instructions should include step by step procedures for checks before the first start, checks after starting and operational tests.
The purpose for the irrigation system and background should be described to allow the commissioning report to be read as a standalone document in the future by operators and their maintenance technicians.

2. WHO IS INVOLVED

The expectations of three primary groups that either “advise”, “produce” or “take ownership” for the systems being commissioned will have differing expectations on why commissioning is needed, what it is and how it should be done. A simplistic comparison of expectations that are typical for designers, installers and operators is given in the following Table 2.

Table 2. Commissioning expectations

<table>
<thead>
<tr>
<th>Designer</th>
<th>Installer</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>• That the systems should be installed in accordance with the intent of the drawing and specification.</td>
<td>• That the installation was done in accordance with the letter of the drawings and specifications as interpreted by the installer.</td>
<td>• Knows where the responsibility for each stage of development rests and when the transfer point is.</td>
</tr>
<tr>
<td>• That the final drawings and specifications convey the needs of the operators.</td>
<td>• That if the systems do not function to meet the expectation of others, that the design is at fault and changes will require scope increase.</td>
<td>• That the systems are installed in accordance with the needs of the operator as proposed by the designer.</td>
</tr>
<tr>
<td>• That parts, sub-systems components, etc. have been run-in by the installer to confirm operational suitability prior to start-up and commissioning so that no delays will occur.</td>
<td>• That the start-up and commissioning will not exceed an unrealistic time scheduled by the installer.</td>
<td>• That once the system is accepted, the controller may be reconfigured by Operators to suit their own needs.</td>
</tr>
<tr>
<td>• That all checks and tags (locked valves or electrical isolators) are verified safe prior to start-up and commissioning.</td>
<td>• That the operator should accept parts or subsystems unconditionally once a start-up has been achieved if specifically allowed for in the terms of the contract.</td>
<td>• That, under warranty terms set out in the contract, if a component or system fails, the installer is responsible and the problem will be fixed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Where an independent verifier has been nominated in the contract, that this person will ensure contractual requirements are met.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• That start-up and commissioning will follow a detailed plan and all systems will be checked and guaranteed operational in accordance with the operators’ expectations.</td>
</tr>
</tbody>
</table>

Where commissioning, including communication, plans are developed, the components, sub-systems and systems are more likely to be ready for start-up and commissioning at the scheduled dates.

Attendance of operating personnel, suppliers/manufacturers’ representatives, Installer personnel and project design engineers needs to be properly determined and scheduled. The timetable will meet the intended start-up and commissioning exercises where good project management and cooperation is obtained from all participants and where clarity of what is expected is obtained from the outset. Think of the focus of the participants as identified in Table 2 to ensure the overall commissioning expectations are clearly understood and quantified.

A commissioning plan is needed to meet warranty requirements as well as conformance with KPI requirements. It will rarely meet all the expectations of participants if the potential conflicts are not explained and accepted at the outset.
3. RESPONSIBILITIES
Responsibilities of all participants should be clearly identified including designer, installer and operator. Key words/activities that apply to responsibilities are identified in Table 3. The responsibilities should be checked and agreed.

Table 3. Commissioning responsibilities

<table>
<thead>
<tr>
<th>Item</th>
<th>Responsible individual(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Designer</td>
</tr>
<tr>
<td>Timetable</td>
<td>✓</td>
</tr>
<tr>
<td>Budget control</td>
<td>✓</td>
</tr>
<tr>
<td>Scope revision</td>
<td>✓</td>
</tr>
<tr>
<td>Start-up testing</td>
<td>–</td>
</tr>
<tr>
<td>Commissioning</td>
<td>–</td>
</tr>
<tr>
<td>Repairs/troubleshooting</td>
<td>–</td>
</tr>
<tr>
<td>Re-testing</td>
<td>–</td>
</tr>
<tr>
<td>Measurement</td>
<td>–</td>
</tr>
<tr>
<td>Documentation</td>
<td>✓</td>
</tr>
<tr>
<td>Acceptance/approvals</td>
<td>✓</td>
</tr>
<tr>
<td>Transfer of control</td>
<td>–</td>
</tr>
</tbody>
</table>

A responsibility matrix should be used to identify the key activities and responsible personnel. This may be included in part in a contract specification. Add or delete items and names to the list as needed for the project.

If the system is large and complex enough to warrant a commissioning manager, they should be named and their role in the process defined. They will plan all matters of timetabling and communications as necessary supported by the designer, installer and operator as required. They may be an independent appointment or a role agreed within the contract from either the designer or the installer organisation.

It may be necessary to have additional suitably qualified electrical and pump engineers in attendance if these roles are not provided directly from the installation organisation. Electrical certification may be required to meet statutory requirements over and above the commissioning of the overall irrigation system. For warranty compliance where very large pumps are to be started up and commissioned specialist engineers from the pump supplier may need to be in attendance often when associated with diesel power plants.

4. TIMELINES
Where multiple contractors are involved for subsystems (or associated works) coordination, planning and sequence of events that could be dependent on each other needs consideration. Sequence and order of subsystem commissioning also needs to be outlined. An expected time schedule is needed.
The following steps need to be initiated at least one month prior to commissioning start:

1. Prepare a commissioning manual binder, suitably tabbed to contain the administration material and records for the project.
2. Meet with Operator to confirm scope, measurements and actions to be tested, schedule and budget.
3. Confirm the Installer’s and subsystem contractor’s completion of start-up and commissioning timetable with contingency plans.
4. Confirm availability of personnel
5. If using an independent verifier under the contract terms then meet with Operator and Installer to review responsibilities and obtain confirmation.

5. QUALITY CONTROL

Quality control (QC) includes planning, determining a means of assurance and measuring expected results. The QC planning should identify responsibility, results and standards from within the contract and an agreed means of measurement and definitions.

The process provides the work results including means of inspection, testing results checklists etc.

A QC plan should be provided in a section of the commissioning binder for the project.

6. SPECIFIC IRRIGATION SUB-SYSTEM COMMISSIONING

Where available, the Control System philosophy (how the designer intended the system to be run) and any systems description write-ups and construction drawings need to be available to the commissioning manager. These should be used to identify and isolate any special sub systems or components and their function, control ranges and test parameters. This could include systems as set out below.

For complex pump stations Pumping and Instrumentation Diagrams (P&ID’s) should be available from the mechanical or electrical sub-installers or designers. These are needed where complex control systems or motor control panels are installed. P&ID’s are to be used to identify all control equipment and valves and are to be identified clearly with tags. Operating sequences are to be checked within the equipment control ranges as identified in the Control System philosophy and construction Drawings.

For the following equipment manufacturer’s recommendations should be adopted as the minimum standard for commissioning. Their information and checklist processes should be appended to this manual and the generic checklists provided herein for later reference.

- Hydraulic protection valves
- Infield valves
- Irrigation controller
- Disc filters
- Back flush solenoids
- Hydraulic protection valves
- Quick acting pressure relief valve
- Pressure reducing
- Water meter
- Data logging and telemetry capability
- Air valves
- Chemical injection
- Backflow protection devices
- Driplines, pivots, gun or drag-line irrigators (otherwise known as emitters).
7. BUDGET

Transparency around the cost of the commissioning process and the provision for it in the quote needs to be outlined and understood. Budgets are normally provided separately from the plan. This will be prepared by and agreed by all parties. This should be used to administer and control project scope and budget.

8. COMMUNICATIONS PLAN

A champion must be identified as the commissioning authority. The commissioning authority must lead and manage the full commissioning process.

All of the participants should agree on the communications plan reporting structure and should be clearly identified in the commissioning plan. Key contacts, names and availability should be provided in a list for all participants.

9. ADMINISTRATIVE NEEDS AND AUTHORITIES TO ACT

The administrative needs and authorities to act on behalf of the installer and owner during commissioning need to be defined and agreed so that the commissioning manager has the ability to make urgent decisions regarding stopping and starting the system and emergency responses that may be needed to protect staff and equipment. These may need to be specified in the contract specifications. A commissioning binder is to be prepared for each project and is to contain suitable sections for guidelines and project records.

A copy of the commissioning binder is to be filed and provided to the owner/operator at the conclusion of the project and used to record any abnormal events that required authority to be exercised.

10. OUTPUTS

The minimum requirements of commissioning documents are:

1. A list of measured KPI’s and actions as achieved during the commissioning
2. A summary document of all the relevant operating KPI’s and any specific commissioning actions as determined by the designer as identified in the contract
3. Any as-built drawings and information identifying departure from construction drawings or specifications as approved (or not) during the installation process.
4. Manufacturers’ Operations manuals for all items of equipment
5. Maintenance schedule for all items of equipment
6. A final summary O&M plan combining all specific equipment as configured for this particular project.
2. Commissioning documents

1. COMMISSIONING KPI’S AND ACTIONS
As part of the contractual arrangements and commissioning plan a list of KPI’s to measure and actions to complete are agreed. To commission a system a series of steps need to be followed. Recording and reporting the actions taken and values measured will form the basis of the commissioning documents.

In general terms the steps will be similar to what is outlined in Appendix 1. Each individual system will have its own unique requirements which will mean either:

- the steps outlined need to be more detailed
- the order of the steps are changed
- the content of the steps are changed
- steps are added or not carried out.

2. SUMMARY DOCUMENT
Aimed at the owner/operator the summary should contain only the relevant operating performance measurements and as-built information for the O&M manual. It should be the key document that contains the baseline information that is pertinent to the day to day operation of the system.

3. COMPLIANCE REPORT OF WATER METER VERIFICATION
The report will have two components

A. Detailing the correct installation and verification of the water meter
B. A check of the data logger and/or telemetry system confirming the outputs read the same as the input data from the water meter

4. AS-BUILT DRAWINGS
Hard copies of As-Built drawings with detailed indexes and referencing must be provided. Electronic copies of drawings can be AutoCAD or IrriCAD if this is available. In the absence of accurate electronic drawings, well executed hand drawings showing the same level of detail and accuracy could be provided, however the preference is for electronic drawings. All drawings developed during the detailed design should be provided as part of the commissioning documents and include:

- Index sheet with locality plan, project title and list of drawings;
- Overall site plan;
- Detailed site plans with set out data and pipelines
- Piping and Instrumentation Diagrams
- Detailed civil and structural drawings also including pipe long sections;
- Single line diagrams should be produced for all electrical equipment.
- Outline drawings showing equipment arrangement, overall dimensions, weights and foundation arrangements. Schedule of components included in the equipment together with the name of the manufacturer and the component type reference.
- Internal layouts of individual electrical panels are required identifying each component. For multiple items such as motor starters, generic drawings are acceptable for each type of starter.
- Comprehensive drawings to aid maintenance (as distinct from construction) should be supplied. These drawings should be supplemented to include instrumentation and mechanical information as appropriate to allow ease of maintenance.
- Final easement drawings
5. OPERATIONS MANUAL
An Operation Manual should be provided for each piece of equipment. The manual should include but not be limited to:

A. General description, including:
   — A full description of the equipment with a tabulation of dimensions and performance ratings
   — Alignment tolerances and check requirements should be stated
   — Location
   — Principles of operation – basic working description, ranges, including novel features and any automatic control
   — Performance criteria
   — Design criteria
   — Overview of how to monitor the equipment using the control system.
B. Safety management
C. Environmental management
D. Detailed operation for each item including a step-by-step procedure:
   — Description
   — How to operate each of the control system functions (Start-up, Shutdown, Manual and Auto Control)
   — How to monitor the equipment using the control system in all of its operating modes
   — Troubleshooting
   — Stopping
   — Emergency stopping
   — Abnormal operation, as applicable.
E. Software Documentation – this should fully describe the operation of any control software installed and should include the following:
   — Systems overview – an overview of all user software modules including detailed written descriptions, system flow diagrams and logic diagrams.
   — Module descriptions – a complete description of each user software module (program, routine and subroutine) including commented source code listings, flow diagrams, operator interface and resource requirements.
   — Operating instructions – a complete set of user operating procedures including system generation, loading, configuration, start-up, on-line modification, shut-down and general troubleshooting.
F. Record keeping requirements
G. Duty statements for operators
H. Emergency response
I. Cross references to the maintenance schedules.
6. MAINTENANCE SCHEDULE
The Maintenance Schedule should be prepared for all mechanical and electrical equipment including control and instrumentation systems. A basic schedule of tasks against time forms the basis of the schedule.

The Maintenance Schedule should include but not be limited to:

- Key contacts
- Routine maintenance – step by step procedure for preventive maintenance work carried out at intervals of two weeks or less.
- Periodic maintenance – step by step procedure for fault correction and preventive maintenance carried out at intervals in excess of two weeks, involving replacement of consumables only. A list of any necessary special tools should be included.
- Test data and troubleshooting – instructions to qualified tradesmen for assessing the operational performance of the equipment.
- Schedule of tasks against time
- System user and supplier responsibilities
- Spare parts list – illustrations and schedules for identification and specifications of all items in the equipment. The recommended spare parts stock must be indicated.
  — As an appendix if needed – Repair, overhauling and dismantling – step by step procedures to extract, fully dismantle, re-assemble and re-install the equipment.

7. ELECTRICAL COMPONENTRY COMMISSIONING, MAINTENANCE AND DOCUMENTATION
Details of the mains switchboard, control panels, and distribution boards. Information to be presented on the drawings include, but are not limited to the following:

- Construction details
- Dimensions, overall and of individual sections
- Component details including layout, component reference, make and catalogue number
- Wiring diagrams
- Drawings showing details of the boards, location of earths, meters, mains entry points
- Test certification.

The maintenance manual should provide a full description of the electrical systems that have been provided as part of the contract.
3. Training

As part of the commissioning and handover process appropriate training should be provided to ensure the owner and staff are adequately trained in the operation and maintenance of the system. Training should be completed before contractual completion with the intention that it is completed during the final commissioning tests.

Both the installer and designer should coordinate to deliver training for the owner.

Depending on the complexity of the system the following steps may need to be undertaken:

- Outline a training methodology.
- Develop a practical training programme aimed at preparing staff for the management, operation and maintenance of the irrigation scheme.
- Detail documentation and training manuals to be provided.
- Detail any vendor documentation and training manuals to be provided.

As part of the training the Installer should arrange for the vendors of equipment included in the works to provide training to meet the specific operations and maintenance requirements of their equipment.

4. Flushing

Flushing of the system is required prior to commissioning. Successful flushing typically requires:

1. Key elements to remain disconnected until flushing has been completed. This includes sprinklers and lateral lines.
2. Defining flushing velocity: Sufficient velocity to ensure material in pipe is mobilised. This may be limited by the capacity of the pump.
3. Defining flushing time: Sufficient time to ensure material is transported through the system. A theoretical transport time can be calculated but it is sensible to allow for material to move more slowly than the water so a conservative time is advised (6 x fluid transport time is not overly conservative).
4. Defining flushing points; typically:
   - end of the line
   - off the bottom of pipes
   - ideally a sluice valve.
Appendices

Appendix 1: Commissioning process

1. COMPLETE COMMISSIONING PLAN

Commissioning plan checklist

The following section provides a checklist to complete to have a comprehensive commissioning plan prior to the commissioning exercise to ensure it goes smoothly.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify commissioning manager and primary contact personnel. Unless someone more appropriate is available or appointed, the Designer should be prepared to take control.</td>
<td></td>
</tr>
<tr>
<td>Prepare a binder to contain the commissioning program and records. This may need suitable tabs for large complex systems. The binder can form the start of the O&amp;M manuals.</td>
<td></td>
</tr>
<tr>
<td>Confirm what components are to be tested.</td>
<td></td>
</tr>
<tr>
<td>1. Power supply – safety, compliance, failsafe</td>
<td></td>
</tr>
<tr>
<td>2. Intake performance – CoP &amp; std compliance, structural integrity</td>
<td></td>
</tr>
<tr>
<td>3. Motor performance – CoP &amp; std compliance, KPI</td>
<td></td>
</tr>
<tr>
<td>4. Pumps performance – CoP &amp; std compliance, KPI</td>
<td></td>
</tr>
<tr>
<td>5. Mainline and distribution network – CoP &amp; std compliance, leaks</td>
<td></td>
</tr>
<tr>
<td>6. Valves – CoP &amp; std compliance, operational ability</td>
<td></td>
</tr>
<tr>
<td>7. Filters – CoP &amp; std compliance, operational ability</td>
<td></td>
</tr>
<tr>
<td>8. Control systems – operability</td>
<td></td>
</tr>
<tr>
<td>9. Water meters – CoP &amp; std compliance, verification</td>
<td></td>
</tr>
<tr>
<td>10. Telemetry – accuracy, operability</td>
<td></td>
</tr>
<tr>
<td>Assemble commissioning team – Identify who will be responsible for each commissioning component</td>
<td></td>
</tr>
<tr>
<td>Identify, define and list sequence of tasks and subtasks to ensure completion</td>
<td></td>
</tr>
<tr>
<td>Identify and list specific tasks each team member is responsible for and which, manufacturer’s or sub Installers representatives should be advised to attend the commissioning event.</td>
<td></td>
</tr>
<tr>
<td>Identify and arrange a suitable commissioning date(s) when the commissioning process is scheduled to commence and finish – with both the Installer and Operator and ensure each is advised of what assistance they should provide. The Designer may also need to be in attendance for complex systems.</td>
<td></td>
</tr>
<tr>
<td>Identify any contractors outside of managers direct jurisdiction and coordinate to enable commissioning completion</td>
<td></td>
</tr>
<tr>
<td>Obtain pre-commissioning documents</td>
<td></td>
</tr>
<tr>
<td>1. Consents</td>
<td></td>
</tr>
<tr>
<td>2. Design drawings and details</td>
<td></td>
</tr>
<tr>
<td>3. KPIs – Understand what information and how to gather and measure it.</td>
<td></td>
</tr>
<tr>
<td>4. Variances</td>
<td></td>
</tr>
<tr>
<td>As built drawings and plans – construction, P &amp; ID’s</td>
<td></td>
</tr>
<tr>
<td>Identify any possible impact on overall property operations</td>
<td></td>
</tr>
</tbody>
</table>

Remember that safety is a key component in all activities. Ensure the personal protection for all participants.
2. OBTAIN PRE-COMMISSIONING DOCUMENTATION

Pre commissioning documentation

1. Consents and conditions
2. System concept design drawings and details
3. Design KPIs of system
   i. Required Service Period.
   ii. System down Time.
   iii. Maximum Daily Application.
   iv. Maximum Return Period.
   v. Maximum System Required Flowrate.
   vi. Maximum Water Abstraction rate.
   vii. Minimum Application Uniformity (e.g. DULq).
   viii. Maximum Soil Application Intensity.
   ix. Energy Input in KW or whatever is appropriate (e.g. Amps and Voltage or Diesel consumption per hour).
   x. Pressure and Flow Values at critical points for all required duties.
      — US of pump
      — DS of pump
      — DS of Headworks
      — Critical Points in Mainline
      — US of irrigator/Zone valves
      — DS irrigator/Zone Valves
      — Critical points within irrigator/Zones (pressure only).
4. As-built variances to design and agreement documentation
5. As-built drawings and plans
   i. Construction Drawings.
      — Overall Layout showing underground pipes, cables ecetera.
      — Zone Layouts and Valves.
      — Pump Station and Headworks.
   ii. Hydraulic Model, P and ID and Flow Schematics.

3. UNDERTAKE A HIGH LEVEL INSPECTION AND COMPLETE PRE-COMMISSIONING CHECKS

A site inspection and checks is undertaken to:

- Determine if commissioning can proceed
- Gain familiarity
- Identify problems to be immediately addressed.
- Identify anomalies and potential hurdles
- Undertake Health and Safety Audit.

Pre-commissioning and high level checks include:

- Reviewing both safety issues and the basic commissioning plan with all present.
- Ensuring that water supply is available for pump testing and any necessary consents are in place to allow extraction and discharge of test volumes.
- Ensuring the Power Supply is available. (Power is assumed to be electricity if power is diesel then a different set of procedures are required).
- Ensure that any required safety equipment will be available and its use and hazards are understood by all those associated with the commissioning process. This might include sound ear muffs, hard hats, confined space (open trenches for pipe joint inspections) entry apparatus, open water egress provisions, etc.
- Ensure that any required PLC programming and commissioning instrumentation will be available. This might include clamp on flow meters, pressure gauges, etc where installed instruments need to be verified.
- Confirm the situation of line valving and the end-of-line consequences.

Pre-plan the commissioning event as much as practical; particularly be ready to assign appropriate tasks to manufacturer’s representatives in attendance.

4. UNDERTAKE COMMISSIONING

Stage 1 tasks

Stage 1 is effectively ensuring that all of the system components are in place and operating, specific KPI measurement and stress testing is not carried out.

Prepare system for Testing and Operation

a. Fill main pipe system with water. As Built Documentation should detail specific procedures. In general the following will need to be followed:
   i. A method for getting water into the pipe is required. It may be that the pump will need to be running although not fully commissioned to achieve this.
   ii. The system needs to be in as open mode as possible to allow air to escape. Normally air relief valves will be installed to achieve this.
   iii. The filling velocity needs to be as low as possible. About 0.15 to 0.3m/s. This will minimise the risk of water hammer damage during filling. Patience is required.
   iv. On-going monitoring of the process is required to ensure that issues are identified and solved before adverse consequences are.

b. Switch power on by qualified electrician.
Testing of Individual Elements for connectivity, safety and operability

a. Mains Power Supply by Qualified Electrician:
   i. Mains to transformer Inclusive.
   ii. Transformer to Switch Board.
   iii. Switchboard
   iv. Other Elements I.e. pump motors.
   v. Check switches work.

b. Main Pipes:
   i. Check air relief valves all operating.
   ii. Check all air obvious air has been expelled. Air relief valves should no longer be venting or sucking air.
   iii. Check for obvious leaks.
   iv. Check manual valves work.
   v. Check all pressure gauges and transducers are reading appropriate static head.

c. Pumps, Headworks (Filters, valves and above ground pipe and ancillaries):
   i. Complete pump station checklist detailed in Appendix 2
   ii. Check for obvious leaks.
   iii. Check for loose bolts, fittings etc.
   iv. Check manual valves work.

d. Irrigation Zones:
   i. Check for leaks.
   ii. Check manual valves working.
   iii. Check Pressure gauges reading appropriate pressure reading.

Stage 2 tasks
Stage 2 tasks require measurement and testing different elements with pressure and across the operating range.

Pumps — Electrical
This will require both mechanical and electrical input (See schedule 2 for specific pump station checklist).

1. Provide the means of allowing pump to be operated through its range without risking the main pipe or pump. This may require isolating from the main line and providing an alternative sink.
2. Provide a suitable method to measure flow and pressure. This is likely to be equipment already installed.
3. Check Pump Operation.
   a. Stop/Start.
   b. Confirm pump is spinning in the correct direction.
      i. Speed ramping if available.
      ii. Safety switch operations.
      iii. Verify and record pump duty characteristics across a range of flows.

Headworks
2. Check Valves. Check they seal properly.
3. Automatic Valves.
   a. Confirm purpose.
   b. Check pilot plumbing.
   c. Check manual override on/off function.
   d. Check electronic remote on/off and control functions.
   e. Check hydraulic pilot control functions, e.g. Sustaining, reducing etc.

Filters
1. Check head loss at design flow.
2. Check automatic cleaning operations.
   a. Start stop settings
   b. Overall operation

Pressure Gauges
1. Check gauge reads correctly against master gauge.

Flow meters
1. Verify accuracy according to current regulations.
2. Verify accuracy of logged data and telemetry outputs (if installed) against meter displays
Distribution network
Operate at pressures to test pipe system.
1. Pressure test as per specifications against PN rating.
2. Check for obvious leaks.

Zones and irrigators
1. Application equipment
   a. Complete manufacturers commissioning recommendations and process
   b. Ensure control panel functional and accurate
   c. Ensure travelling irrigators can complete their full length and range of travel successfully
   d. Sprinklers positioned correctly and free from obstruction
   e. Check structural integrity, loose bolts, fittings etc
   f. Check for leaks
   g. Check manual valves working.
2. Emitters – sprinklers, drippers, micro sprinklers
   a. Check all individual emitters spray pattern is correct
   b. Check sprinkler package correctly fitted on Pivot
   c. Check emitters free of obstructions
   d. Check all connections
   a. Check Valves. Check they seal properly.
   b. Automatic Valves.
   c. Confirm purpose.
   d. Check pilot plumbing.
   e. Check manual override on/off function.
   f. Check electronic remote on/off and control functions.
   g. Check hydraulic pilot control functions, e.g. sustaining, reducing, etc.

Control system
1. Check operability
2. Check individual operation of valves/pumps.
3. Check accuracy of output information.

Final commissioning
1. Test each zone individually and calculate KPI’s.
   b. Flow rate.
   c. Pump inlet Pressure.
   d. Pump Outlet Pressure/Filter Inlet Pressure.
   e. Headworks/Filter Outlet Pressure.
   f. Key mainline pressures (low and high points).
   g. US Zone Valve pressures.
   h. DS Zone Valve pressures.
   i. Individual Emitter flows and pressures.
   j. Nearest Sprinkler/emitter.
      i. Farthest Sprinkler emitter
      ii. Highest Sprinkler emitter
      iii. Lowest Sprinkler emitter.
   iv. Random selection of in between emitter/sprinklers.
   k. Minimum Application Uniformity (e.g. DUlq).
   l. Maximum Soil Application Intensity.
2. At lowest envisaged duty.
3. At highest duty.
4. Mock emergency scenarios: Check to see how system responds.
   a. Pipe break.
   b. Pump/Power failure.

5. DOCUMENTATION
1. Record information appropriately
2. Complete compliance reports
3. Store and collate information to complete As Built Information
4. Provide final documentation to owner.
## Appendix 2: Pump station commissioning checklist

<table>
<thead>
<tr>
<th>Activity</th>
<th>Checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not take safety risks, regardless of the pressure or voltages. Ensure that one person is always standing by especially when access is by ladder.</td>
<td></td>
</tr>
<tr>
<td>Generally mechanical/electrical commissioning procedures should be undertaken in parallel with automation commissioning procedures so that there is a minimal loss of time.</td>
<td></td>
</tr>
<tr>
<td>Calibrate instrumentation as required.</td>
<td></td>
</tr>
<tr>
<td>Program any VSD (Variable Speed Drive) or SS (Soft Starter) units involved.</td>
<td></td>
</tr>
<tr>
<td>Confirm the setting of safety devices, such as overload sensors and relays, timers.</td>
<td></td>
</tr>
<tr>
<td>Check pump motor rotation: Note that the correct direction of rotation for any centrifugal pump with a volute casing will be the same as the discharge tangent points. A centrifugal pump will always move liquid out the discharge, regardless of motor rotation, so detecting flow is not a guarantee of correct rotation. Proper phasing must be confirmed.</td>
<td></td>
</tr>
<tr>
<td>Stand away from the motor while someone “bumps” it then, just before the motor coasts to a stop, carefully observe the direction of rotation of the impeller shaft at the fan cooling end where visible. If necessary disconnect the pump and observe the rotation of the impeller. NEVER insert anything including fingers into a pump to check rotation.</td>
<td></td>
</tr>
<tr>
<td>If not practical, the pump can be operated in both directions and the correct direction of rotation will be that which produces the best performance and least pump noise.</td>
<td></td>
</tr>
<tr>
<td>The rotation of a submersible well pump can only be determined by operating in both directions, and the correct direction of rotation will be that which produces the best pump performance. Note that reverse rotation will not harm the pump or motor.</td>
<td></td>
</tr>
<tr>
<td>Ensure that any pump inlet valves are full open (gate valve handwheels should be turned until they stop, then backed out ½ turn).</td>
<td></td>
</tr>
<tr>
<td>Pump discharge valves should normally be full open. They may be partially throttled if the line is not filled. (Line filling procedures should be approached with considerable caution and filling rates determined by the Designer according to air relief rate allowances.)</td>
<td></td>
</tr>
<tr>
<td>Butterfly valves can be closed by an uneven (turbulent) flow pattern. Confirm butterfly valves vanes are properly oriented relative to flow patterns especially where adjacent to elbows. Ensure the handles are securely latched in place.</td>
<td></td>
</tr>
<tr>
<td>Ensure that pump casings are properly vented using air bleed points if necessary.</td>
<td></td>
</tr>
<tr>
<td>Ensure all thrust anchors, tie back bolts and safety components are secure.</td>
<td></td>
</tr>
<tr>
<td>Start pumps using a manual control switch. If the pump is either extremely noisy (blocked inlet) or extremely quiet (airlocked) immediately stop the pump. Beware of vertical turbine pumps that are extremely quiet (airlocked) as their water lubricated bearings can fail in a matter of seconds!</td>
<td></td>
</tr>
<tr>
<td>With the pump running, check operating amperage, which should be reasonably close to nameplate. Immediate concern is warranted only if in excess of motor service factor amperage.</td>
<td></td>
</tr>
<tr>
<td>With the pump running, check operating voltage on all leads.</td>
<td></td>
</tr>
<tr>
<td>Briefly check the pump discharge pressure at shutoff head. This is an excellent indication of pump performance and if this agrees with the published pump curve, chances are high the pump is performing correctly.</td>
<td></td>
</tr>
<tr>
<td>With the pump control switch in AUTO, simulate operating levels and/or pressures to confirm proper operation of the control system. Finally, observe actual system operation for as long as practical.</td>
<td></td>
</tr>
<tr>
<td>The ramp-up and ramp-down time settings of VSD and SS units, or the opening and closing time settings of pump control valves should generally be a 1:2 ratio. In other words, ramp-down or closing should be double ramp-up or opening. As a starting point, ramp-down/closing times should be about 10s for pumps up to 10kW, about 20s for pumps up to 25kW, about 30s for pumps up to 40kW, about 45s for pumps up to 150kW.</td>
<td></td>
</tr>
<tr>
<td>When commissioning automatic valves, first ensure all cocks are open, then vent the cover. Confirm that the valve is properly flow direction oriented. Do not tamper with factory pre-adjusted pilot settings.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3: Example as-built plans
TYPICAL TRENCH DETAIL: MAIN PIPE

TYPICAL TRENCH DETAIL: SUB-MAIN PIPE

TYPICAL TRENCH DETAIL: MULTI PIPE
NOTE:
ALL UNDERGROUND PIPEWORK TO BE PE 80 PN8 UNLESS OTHERWISE STATED.

#   = PIPE ACCESSORY (REFER TO SHEET 603)
#   = PIPE SUPPORT TYPE (REFER TO SHEET 604)
NOTES

DISCLAIMER AND COPYRIGHT
The information provided in this publication is intended as a guide and reference resource only and should not be used, relied upon or treated as a substitute for specific professional advice. While Irrigation New Zealand Limited (including its officers, employees, contractors and agents) (INZ) has taken all due care in the preparation of the information in this publication, INZ cannot guarantee that every statement is factually accurate.

INZ makes no warranties, guarantees or undertakings as to results that may be obtained from information in this publication. You are solely responsible for the actions you take in reliance on the content provided in this publication.

INZ shall not be liable for any errors or omissions in the information or for any loss, injury, damages of any type (including and without limitation direct, indirect, special or consequential damages) or other consequence whatsoever that you or any person might incur as a result of your use of or reliance upon the information which appears in this publication.

The information contained in this publication may change, be added to, deleted or otherwise updated or amended without notice. Except where expressly stated, the information in this publication is protected by copyright. You may not copy, reproduce, modify or distribute the publication or parts thereof in any way, other than a single copy for private use. Permission must be sought from INZ prior to reproduction of any material contained in this publication.

Any information that is referenced or links that are included in this publication are provided for your assistance and convenience. INZ provides no warranty or endorsement whatsoever and is not liable or responsible for the content or accuracy of any third party websites or publications.

Each page of this publication must be read in conjunction with this disclaimer and any other disclaimer that forms part of it.