Functional Requirement Specification

PIP-II Low Conductivity Water System

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Revision History

Revision	Date	Section No.	Revision Description
-	02/28/2017	All	Initial release.
1	TBD		

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1 Introduction

The Low Conductivity Water (LCW) System will provide cooling for the majority of the water-cooled equipment throughout the PIP-II [1] accelerator beamline and galleries. The RF sections that power the LB650 and HB650 cavity sections of the accelerator are the largest users of the LCW System at approximately 73% of the total water flow and power dissipation. The pump room for the PIP-II LCW System will be located in the PIP-II Utility Building located in the vicinity of the Front End Building. Heat load rejection from the LCW system will involve the use of a fluid cooler tower system, located adjacent to the PIP-II LINAC Service Building.

This specification describes functional requirements for the LCW system

2 Key Assumptions and Interfaces

The LCW System shall provide supply and return manifolds in the following areas:

- Front-end highbay
- Front-end gallery
- SC linac beamline
- SC linac gallery
- Transfer line beamline
  - includes beam abort beamline
  - includes heat exchange with beam abort RadioActive Water (RAW) system

Long-life components of the LCW System shall be designed for flow requirements corresponding to the full CW power of PIP-II (approximately 7MW rejected to LCW). For example, piping runs and interface valves should be sized for CW.

Limited-life components (e.g. pumps) or limited-range components (e.g. flow meters) of the LCW System may be sized for the reduced flow requirements of PIP-II operating in pulsed mode (approximately 1.7 MW rejected to LCW). An upgrade list shall be prepared of any components requiring replacement for the LCW System to accommodate CW operation.

The LCW System has the following major interfaces:

Conventional Facilities – CF provides physical space, utilities, and heat rejection for the LCW System.

Water-cooled devices – The LCW System has an interface to each device requiring water. This interface shall be negotiated at Level 3 of the PIP-II WBS and documented in an interface control document.

Controls – the LCW System shall report key system parameters to ACNET.

Machine Protection System (MPS) – The LCW system shall monitor its own health and flow instrumentation report status to the MPS.

3 Requirements

3.1 Performance Requirements

The LCW System shall meet the design requirements of Table 1. The following requirements apply at all interface locations where the LCW System supplies LCW to components, at all times, and in all seasons.

All items listed in the "Nominal" column are **not** requirements, and are listed for information only. All interfacing hardware must be compatible with the full range of parameters as defined by the "Min" and "Max" columns.

Table 1. LCW System Performance Requirements

	Min	Nominal	Max
Temperature Requirements			
Supply temp at the manifold	83F (28.3C)	85F (29.4C)	88F (31.1C)
Supply temp stability over any 24h period*	-	-	+/- 2F (+/- 1.1C)
Settling time after step change to heat load**	-	-	5 min
Pressure Requirements			
MAWP** * of system	-	-	120psig
System relief valve setting	95psig	105psig	110psig
Supply Pressure at manifold	80psig	90psig	110psig
Return Pressure at manifold	5psig	10psig	20psig
Pressure drop between supply and return	60psi	80psi	105psi
Water Quality Requirements			
Water Resistivity	5MΩ-cm	8MΩ-cm	12MΩ-cm
Dissolved Oxygen	1ppb	5ppb	10ppb
Estimated Flow delivery****			
To front end gallery	-	1E2 gpm	-
To front end highbay	-	1E2 gpm	-
To linac gallery	-	3E3 gpm	-
To linac tunnel	-	1E2 gpm	-
To transfer line tunnel (including abort)	-	2E2 gpm	-

* Temperature stability requirement applies while heat load rejected to the LCW System is stable to within 200kW (i.e. approximately 10% of the full heat load in pulsed mode)

** Settling time is the time required for the system to meet the +/-2F stability requirement after a step change in heat load > +/- 200kW.

***MAWP = Maximum Allowable Working Pressure (used as a basis for design, relief valve setting, and pressure testing in LCW system and connected components). All connected components shall be specified, designed, and tested for the same MAWP.

****Explicit flows are NOT required at the FRS level, in that they will change as detailed designs are developed. These values are given so that the casual reader can get a feel for the approximate scope of the system.

3.2 Configuration Requirements

The LCW System shall be compatible with the presence of copper piping, either in the LCW system itself or in devices receiving cooling. As such, aluminum in either the LCW system itself or in devices receiving cooling is not recommended due to the possibility of corrosion.

The LCW System shall provide filtration adequate to manage the accumulation of copper oxide particulate

3.3 Lifetime and Uptime Requirements

The LCW System shall be designed for a lifetime of 50 years (with appropriate maintenance).

The LCW System shall provide better than 99% uptime, except for during planned maintenance periods.

3.4 Engineering and Documentation

The LCW System shall conform to FNAL Engineering [2] and ES&H Standards [3].

The LCW System design information shall be captured in a Teamcenter EPDM

The LCW System engineering documentation, including Piping and Instrumentation Diagrams, shall be stored in Teamcenter

4 References

[1] PIP-II Conceptual Design Report
http://pip2-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=1

[2] Fermilab Engineering Manual
http://directorate-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=34

[3] Fermilab ES&H Manual
http://esh.fnal.gov/xms/ESHQ-Manuals/FESHM