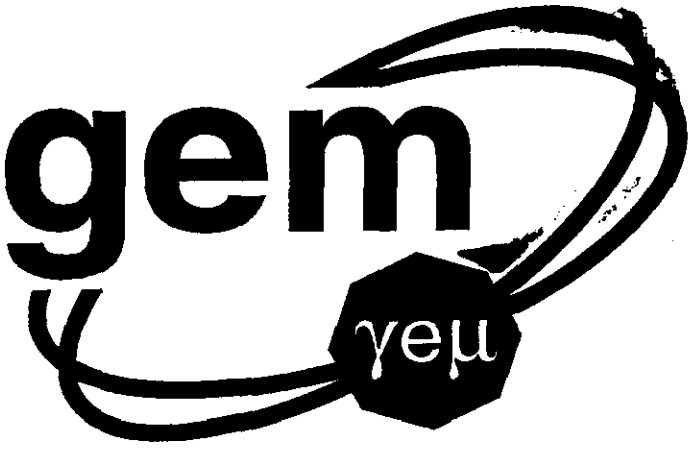
93-448 DRAFT

Ed Hutton



Preliminary Design Requirements

Muon Gas System
(GEM WBS 522.5030.02.5)
Gamma, Electron, Muon Detector Collaboration
Superconducting Super Collider Laboratory

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Revision Record

SCN No.	Description	SCN DC No. SDT-	ECR No. E20-	Date Apvd.
	Initial Issue			

Purpose

The purpose of this document is to define and present the operational, engineering and project requirements of the Gamma, Electron, Muon Detector Collaboration (GEM) for the Muon Gas system supporting the GEM Detector at the SSC Laboratory. An overview will be provided to relate the function of the gas system with the Detector systems. Component requirements, design parameters and flow rates will be presented in the overview for the gas system. The operational requirements presented will apply to the control of, as well as the reliability and maintainability of the system with respect to the Detector. Engineering requirements will address and define procedures for environmental safety and health issues, quality assurance, testing methods and code and standard requirements. Finally, project requirements such as schedule milestones, system costs, risk and abatement strategies and system interfaces will be provided for review. The requirements presented in this document are the extension and elaboration of the criteria specifications contained in the *GEFUR(Document Number GCT-00001*. The format and content of this document are consistent with guidelines presented in the *SSCL Engineering Management Plan,* document number E10-000029, Rev. A and the *GDC Project Management Plan,* document number GGT-000006 (DRAFT). This document is the first in the SSCL design review sequence, followed by a *Preliminary Design Report,* a *Critical Design Report,* and an *Acceptance Test Plan Report.*

Scope

The Gamma, Electron, Muon Detector Collaboration will be the "customer" for the systems described in this document. The Collaboration has engaged the Physics Research Division/Experimental Facilities Department/Mechanical Group(PRD/EFD/ME) of the SSCL to provide engineering for the muon gas system supporting the GEM Muon Detector System

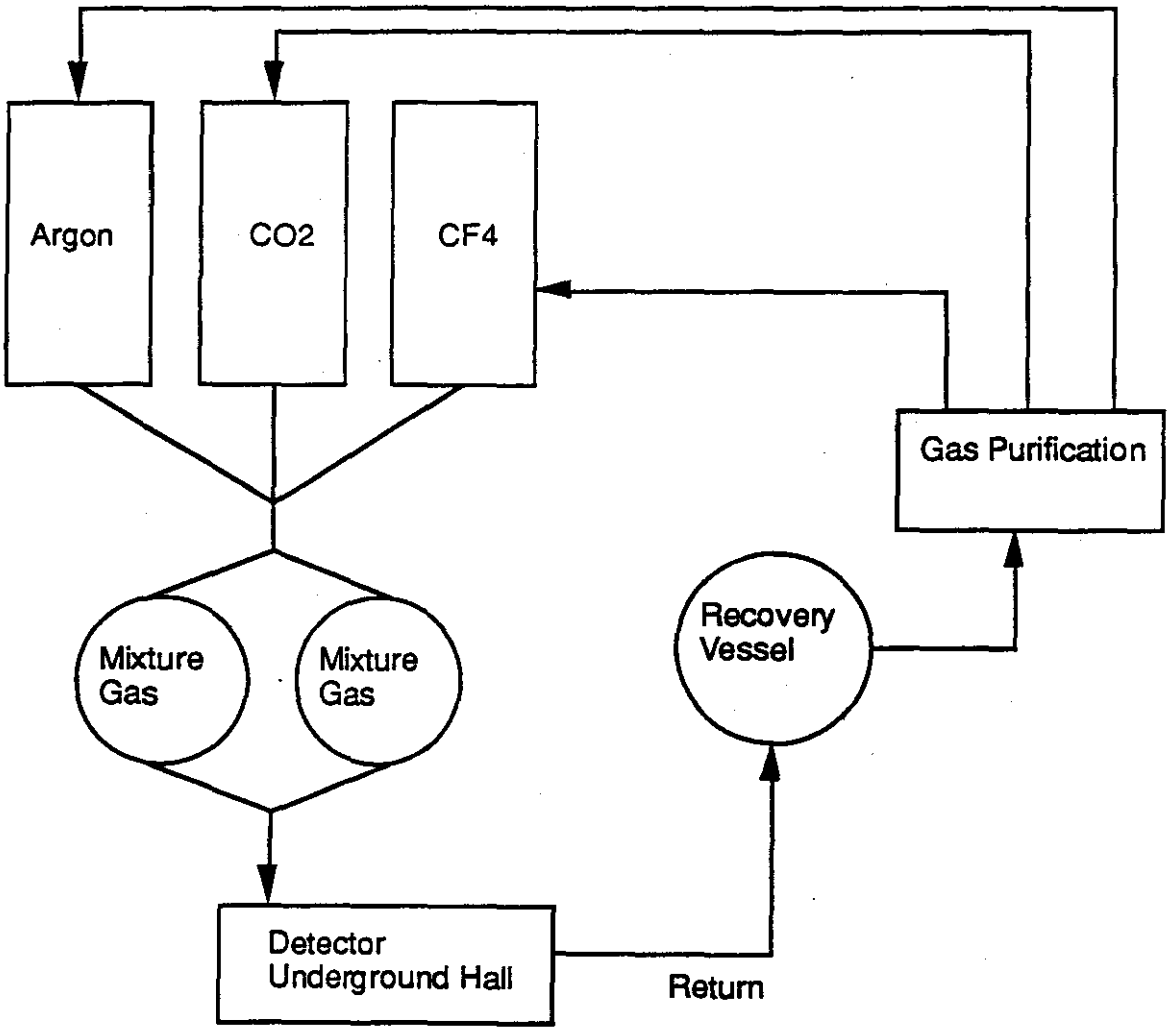
The EFD Mechanical group will maintain overall responsibility for the gas system project segment as contained in the GEM WBS dictionary Section 522.5030.02.5 & 522.5030.03.5. The scope of this segment includes management, design, procurement, inspection and testing involved in the fabrication, installation, commissioning, integration, and start-up of the muon gas system supporting the GEM Muon Detector. In order to fufill the scope of work defined in this segment, concerted efforts must be made to communicate all requirements to EFD as early as possible to streamline the preliminary design process.

Systems' Overview and General Requirements

System Philosophy

1) The gas system will mix and charge gas system supply vessel with specified gas mixture.
2) The system will supply muon chambers with gas mixture from a storage vessel per chamber requirements and collect return gas in a recovery vessel for later gas purification.

3) Used gas mixture stored in the recovery vessel will be purified, separated, and returned to the individual storage vessels for later reuse.
4) Following consumption of the first mixed gas supply vessel, the gas system will switch to a second mixed supply vessel to allow recharging of the first vessel and continued gas supply to the muon chambers.



Muon Gas System Characteristics

The primary function of the GEM gas system is to provide drift gas for each muon chamber located within the GEM detector.
1) Muon Chamber Volume: Barrel 140 m^3 EndCap: 80 m^3 Total: 220 m^3
2) Operating Pressures
Muon Chamber Inlet Manifold: 125 Pa gauge (0.5 inch of water)
Set Point Inlet Press Tolerance: ± 20 Pa
Module Flow Pressure Drop: Normal: 10 Pa,
3) Total Flow Rate Max: 4 changes/24 hrs Normal: 2 change/24 hrs
4) Gas Purity (min Level): 99.95%
5) Gas Mixture: Carbon Dioxide 50% by volume
Argon 30%
CF4 20% (percentage stability for each constituent ±1.5%)

6) Gas Contamination:

Hydrocarbons	<50ppm	Halogens	<10ppm
Nitrogen	<250ppm	Water	<100ppm
Oxygen	<50ppm	Nitrous Oxides	<100ppm

7) Temperature Inlet: hall stable ambient or 22.8 °C Tolerance: ±2 °C
8) Interface Point & Connection Type: Each Chamber Supply & Return Manifold connector individually documented in Muon Utilities Interface Document
9) Gas System Maximum Data Recording Requirements:
Supply Temperature - 2 times/minute
Manifold Supply Pressure - 2 times/minute
Module Return Gas Analysis - 3 times/day
10) Filtration will be included to remove dust & oil from gas flow prior to muon chambers.

Operational Requirements

The drift gas system will be operating in the following modes:

1. System Startup

During initial checkout the gas system operation must support installation of the muon detector. This will require the gas system to supply sufficient fresh gas supplies necessary to remove atmospheric contamination of each chamber due to the construction and assembly process. Provisions should also be implemented to allow the application of a vacuum on the gas system to remove contaminates from the system prior to chamber connection and operation.

2. Steady-State Operation

The gas system will operate normally in a continuous closed system mode. This mode will recirculate the gas from the surface through the Utility Shaft to the muon system for distribution to the individual muon detectors chambers in the detector hall. The gas system will then return the gas to the shaft and/or surface for purification, pressurization, and temperature conditioning. During beam-on operations, the gas system should retain the gas within the hall or the gas system due to gas activation. The gas system should not have uncontrolled release of gas to the atmosphere, but in the event of a component failure may allow release of gas into the hall during beam operations. During beam-off operations there are no restrictions to gas release to the atmosphere.

3. System Purge

The gas system can be operated in a purge mode to decrease gas system contamination by increasing the flow rate and discontinue recirculation of the gas. The purge mode would be used following system installation and maintenance.

Controls:

The gas system will be controlled by a Distributed Control System, with remote readout and limited controls linked to the main GEM control center. The gas system must be able to operate unattended during steady-state operation, and maintain stability during

atmospheric variations automatically. The controls of the gas system will meet requirements of stand-alone operations utilizing applicable hardware and software, yet will allow for manual operations as desired. The purification and mixing modes may require some operator participation. Critical controls, such as flammable gas and ODH sensors, must be supported by an uninterruptable power supply (UPS) to allow safe shutdown in the event of power failure or other emergency. A detailed description of control system requirements will be provided as a separate document.

Reliability and Maintenance:

Operation of the accelerator is planned for nine continuous months per year with an average of no more than one day per week allowed for maintenance. The muon gas system must be designed to maintain gas flow using stored quantities or premixed supplies for 24 hours in the event of failure of the gas mixing system. There must be sufficient redundancy in the design to minimize the impact of failure of a large subsystem. While the accelerator is in operation, there can be no access to the detector hall due to high radiation. This places additional emphasis on the reliability of gas equipment in the shaft, tunnel, and detector hall. Equipment below ground level must be sufficiently radiation-hard to provide a 20 year life in a 50 RAD/hr radiation environment with minimal maintenance. Commercially purchased parts or components for the system must be readily available from U.S. sources.

Engineering Requirements

Environmental, Safety, and Health Requirements:

Design and operation of the gas system must be done in such a way that hazards to personnel and the environment are minimized. ES&H issues will be addressed in accordance with policies and procedures described in the *SSCL ES&H Manual* and in the *GEM Project Management Plan*. A conceptual safety analysis has been prepared, and is described in the *GEM Detector Conceptual Safety Analysis Report (CSAR)*. As the design matures, both a Preliminary Safety Analysis Report and final Safety Analysis Report will be prepared.

Codes, Standards, and Related Requirements:

The systems and designs must meet the following codes and standards:

National Fire Protection Association

NFPA 70	National Electric Code
NFPA 58	Standard for the Storage and Handling of Liquified Petroleum Gases
NFPA 59A	Standard for the Production, Storage, and Handling of Liquified Natural Gas

Occupational Safety and Health Act (OSHA)

U.S. Department of Energy
- U.S. DOE Order 6430.1A General Design Criteria

American National Standards Institute (ANSI)
- B31.3 Chemical Plant and Petroleum Refinery Piping
- B31.5 Refrigeration Piping

B36.19 Stainless Steel Pipe

The American Society of Mechanical Engineers (ASME)
ASME Boiler and Pressure Vessel Code or equivalent

Quality Assurance Requirements:

Both design and manufacturing quality must be actively confirmed in all phases of the project segment. New designs or manufacturing processes must be confirmed by test. Quality Assurance will be carried out in accordance with the DOE orders 4700.1 and 5700.6B, and the *SSC Laboratory Quality Assurance Program* (D70-000001) Document control and configuration management will be carried out using procedures in Section 7.0 of the *GEM Project Management Plan.* Quality assurance procedures for designs or manufacturing processes taking place in foreign countries must be approved by GEM Project Management.

Testing Requirements

Prior to muon chamber purge operation, the surface gas system must be fully commissioned using a detector bypass line at the detector end of the main supply line. The testing program should include tests of all safety and process interlocks, pressure and leak testing, and system operation. A detailed testing program will be described in a future *Acceptance Test Plan Report.*

Project Requirements

The project will be executed using the policies and procedures described in the *GEM Project Management Plan.* The plan includes procedures for configuration management, design reviews, reporting, and other management-related items.

Schedule Milestones:

To meet overall project objectives for schedule, the following milestones relating to the gas system must be met:

Preliminary Design Requirements Review Complete	July 1993
Preliminary Design Review Complete	December 1994
Critical Design Review Complete	November 1995
Major Procurements Complete	December 1996
Acceptance Test Plan Report	December 1996
Gas System Commissioned Assembly Building	October 1997

Cost:

The *GEM Project Cost/Schedule Summary* (GEM Document Number GEM-IN 93-30, DRAFT). includes funding from WBS 522.5030.02.5 and 522.5030.03.5 in manufacturing labor, materials, and contingency for the purchase, installation, and testing of the gas system and subsystems. This does include costs for the distributed control system, but not the AC power, which is not within the scope of this document. Costs of engineering support and design by EFD are provided by SSCL WBS 555.5470 and are not included in the above WBS.

Design of the system should be optimized in terms of both capital and operating cost, while meeting the requirements set forth in this document for operation and reliability. A detailed cost estimate breakdown may be found in the *GEM Cost Estimate Detail Book* .

Risk and Abatement Strategy

The costs estimated for the system are believed to be an optimum balance of 1) capital cost, 2) operating cost, 3) schedule expectations, and 4) project risk. Should the need arise, the Muon Technical Board may elect to reduce the cost of the systems by one of the following means:

- Deferring Purification System
- Using premixed gas supplies
- Extending allowable system purge time
- Eliminating operational redundancy
- Relaxing availability requirements

If it is found that installation of the systems cannot occur within the listed schedule milestones, the Board may choose some of the following options to maintain schedule:

- Add 2nd and 3rd working shifts
- Waive shop inspections and special testing requirements

The gas systems used for this application are anticipated to be relatively standard, proven, technology. Some contingencies for abating technical performance risks are as follows:

- Use of premixed gas
- Elimination of purification circuit

Assembly and Installation Requirements:

The gas system plant will be located in the IR-5 Gas Building, located above the north end of the detector hall. See the GEFUR (Document Number GCT-000001) for a detailed floor plan and layout. All piping, cabling, conduit, etc., connecting the gas system to the muon detector passes down the vertical utility shaft to level 4. The gas system distribution equipment is located on level 4 of the utility shaft, the gas is then piped through level 5 of the utility shaft horizontal tunnel into the detector hall and to the detector.

Electrical power, heating and ventilation, ODH protection systems, and buildings will be provided by SSC per the specifications of the Mechanical Group. Cooling water is provided from mixed chilled water .

Interfaces and Integration

Interfaces with other detector systems, structures, and design groups must be carefully controlled and documented. An Interface Control Document should be prepared to define these interfaces and control changes. Below is a list of some of the interfaces to be considered:

- Detector Hall and Utility Building
- Electrical Power
- Cooling Water
- Control Power
- Installation Coordination
- Fire Protection System
- Main GEM Controls
- Hall Safety Interlocks
- Cryogenic Systems
- Detector Hall Piping Supports
- Equipment Foundations
- Detector Interface

References

Technical Design Report, GEM Collaboration,
GEM-TN-93-262 (SSCL-SR-1219), April 30, 1993

GEM Project Management Plan, Gamma, Electron, Muon Detector Collaboration,
GGT-000006, Draft, April 1993

GEM Project Cost/Schedule Summary , Gamma, Electron, Muon Detector Collaboration,
GEM-IN-93-30, April 1993

GEM Project Cost Estimate Detail, Gamma, Electron, Muon Detector Collaboration,
To be developed at a later date.

GEM WBS Dictionary - TDR Submittal, GGT-000008, April 27, 1993

GEM Experimental Facilities (User Requirements), Gamma, Electron, Muon Detector Collaboration,
GCT-000001, Revision Coo1, February 1993

SSCL Engineering Management Plan, SSC Laboratory
E10-000029, Rev. A, June 1992

SSC Laboratory Environment, Safety, & Health Manual, SSC Laboratory

DOE Order 4700.1 Project Management System, U.S. Department of Energy

DOE Order 5700.6C Quality Assurance, U.S. Department of Energy

DOE Order 6430.1A General Design Criteria, U.S. Deoartment of Energy

SSC Laboratory Quality Assurance Program , SSC Laboratory
D70-0000000

Site Specific Conceptual Design of the Superconducting Super Collider,
SSCL-SR-1056, July 1990

System Specification for the Experimental Systems of the Superconducting Super Collider,
SSC Laboratory, R00-000001, September 1992

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Physics Research Division
GEM Project Office

Memorandum

To: Distribution
From: Mike Harris
Subject: Muon Gas System PDRR
Date: August 31, 1993

On September 8, 1993 at the SSCL there will be a Muon Gas System Preliminary Design Requirements Meeting. The Preliminary Design Requirements are attached for your review. This meeting will be starting at 1:30 in Building 4 in the Upstairs Conference Room.

If you have any questions, please feel free to call.

/lhb

Attachment