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Preliminary Facilities and Utilities Requirements for STAR (P-FURS)

General Experiment Facilities/Utilities Requirements and Interfaces Definition

This document specifies the Preliminary Facilities and Utilities Requirements for STAR (P-FURS). The requirements are derived from the specific subsystem needs and the overall requirements to assemble, operate and service the detector as described in the STAR Conceptual Design Report. The list of requirements presented in this report forms the basis for the Title 1 report. As the detector design moves into the preliminary and final stages, some requirements may be changed. The changes will be conveyed to RHIC prior to the release of the Title 2 report.

The following is a general list of the facilities/utilities requirements:

1. Buildings

- Upgrades to the existing Wide Angle Hall
- New assembly building
- Larger operation/DAQ building
- Gas mixing house and gas bottles storage shed
- Magnet power supply building

2. Electrical Utilities Including Interfaces Definition

- Site Power
    - Primary power
        - Facility Power
        - Magnet Power
        - Experiment Power
    - Secondary Power
        - Power for the buildings, CHW, production and HVAC
        - Emergency Power
- Grounding System

3. Mechanical Utilities Including Interfaces Definition

- Low conductivity water for the magnet
- Chilled water for electronics
- Industrial water for some equipment heat rejection
- HVAC for detector interior and the electronics trolley

4. Interfaces with Accelerator System

- Mechanical Systems Interfaces
- Computing/Communication Systems Interfaces
- Safety Systems Interfaces

1. Buildings

1.A Upgrades to the Existing Wide Angle Hall

The STAR detector will be assembled in the new assembly building, then moved, along with its electronics trolley, to the Wide Angle Hall for operation. The electronics trolley will be accessible for service during operation. For that purpose, a heavy concrete radiation shield will be erected around the trolley. Figure 1 shows the detector during the operation mode. The existing Wide Angle Hall (WAH) will require some upgrades to facilitate operating and servicing the detector. The following is an upgrade requirements list.

1.A.1 WAH Floor Loading

The floor of the WAH must be capable of supporting the detector weight which is presently estimated at 1,200 tons and the concrete shielding blocks. The design of the detector support system is presently in the conceptual stage. The expected detector floor loading will be provided to RHIC when detailed analysis of the support system is completed. The detector will be transported on "Hilman-type" rollers which requires the installation of steel plates in the floor. These steel plates should be installed during the floor modification. The specification and location of the steel plates will be provided at a later date, prior to the Title 2 report.

1.A.2 WAH Doorway Access

The doorway between the WAH and the assembly building should be enlarged to its maximum permissible dimensions to insure that the fully cabled detector can pass through it. A minimum dimension of 27 ft x 27 ft is required. The existing roll up door and its mechanism will not be needed.

1.A.3 WAH General Building Utilities Requirements

Detector -specific utilities are described in Sections 2 and 3. However, a list of general building utilities are listed below.

Electric Power

The electric power in the hall should be sufficient to operate the crane, lights, pumps/compressors and machine tools. A detailed list of power requirement is presented in Section 2. of this report.

Ventilation System

The temperature and humidity of the WAH space should be controlled to insure the proper operation and safety of the detector subsystems. Most electronics will be chilled-water cooled. The maximum HVAC heat load from the detector and its associated auxiliary equipment (pumps and motors) is 150 KW. Additional heat load from heat leaks, lights, etc. should be added to the detector heat load. The average hall temperature is:

Summer: 75 °F @ 55% RH

Winter: 70 °F @ 55% RH

1.A.4 WAH Interaction with the Tunnel

The conditions in the tunnel should not impact the WAH ventilation and safety system. Specifically, possible cryogenic leaks from the accelerator system into the WAH should be avoided.

1.A.5 WAH Safety System

The WAH should meet all relevant building safety codes. Fire sprinkler, smoke detection, ODH, safety lights, regress systems electric grounding should be available at BOD.

1.B STAR Assembly Building

The STAR detector will be assembled, cabled and tested in the assembly building. A mechanical work area and an electronics shop/clean room will be constructed inside the assembly building after the initial magnet installation is completed. The dimension of the assembly building is estimated from a study of the detector assembly sequence. The electronics trolley structure will be assembled outside the building then rolled inside the building for utilities hook-up and electronics racks installation. Figures 2 to 4 show the plan and side views of the assembly building.

The assembly building should have the following general features:

1.B.1 Assembly Building Doorway Access

Two roll-up doors. One large enough to roll in the electronics trolley (30 ft wide), and the other suitable for truck beds loaded with large iron pieces and magnet coils (about 24 ft wide).

1.B.2 Assembly Building Floor Loading

The floor, at least in the area where the detector will be assembled, should be sufficient to support the 1,200 ton detector. Steel plates similar to those in the WAH should be placed in the floor in the designated area to facilitate rolling the detector and the electronics trolley.

1.B.3 Building Crane Requirements

Preliminary crane capacity requirements in the assembly building will necessitate two cranes on separate bridges with the main rails for the bridges running along the length of the hall. One crane should have a 40-ton capacity which is needed to assemble large iron pieces. A second crane with a 10-ton capacity is required to facilitate other assembly operation at the other end of the hall.

1.B.4 General Assembly Building Utilities Requirements

Electric Power

The electric power in the hall should be sufficient to operate the crane, lights, welding equipment, pumps/compressors and machine tools. A detailed list of power requirement is presented in Section 2. of this report.

Ventilation System

The temperature and humidity of the assembly building space should be controlled to insure the proper operation and safety of the detector subsystems. The maximum HVAC heat load from the detector and its associated auxiliary equipment (pumps and motors), with the addition of the heat load from the clean room, the electrical and mechanical shops is 150 KW, which includes the heat exhausted from the trolley. Additional heat load from heat leaks, transformers, lights, etc. should be added to the detector heat load. The average hall temperature is:

Summer: 75 °F @ 55% RH

Winter: 70 °F @ 55% RH

1.B.5 Assembly Building Safety System

The assembly building should meet all relevant building safety codes. Fire sprinkler, smoke detection, ODH, safety lights, electric ground and regress systems should be available at BOD.

1.C Addition and Modifications to the Operation/DAQ Building

The Operation/DAQ building houses the DAQ computers, work stations, electronics racks, experiment operation control consoles, equipment for copying and storage data tapes, and other operation-related equipment.

A new 30 ft X 43 ft building will be added to the existing DAQ/OP building. A preliminary layout showing the modifications and addition to DAQ/OP building is presented in Figure 5.

1.C.1 DAQ Building Doorway Access

The doorway should be large enough to allow computer equipment and electronics racks to pass through. Doors to directly access the assembly building without the need to go outside are also needed.

1.C.2 DAQ Building Floor

12 inches computer floor is required in the Racks/DAQ area.

1.C.3 General DAQ Building Utilities Requirements

Electric Power

The electric power in the building should be sufficient to operate the lights, printers, copying machines and kitchen equipment. Work stations and computers will be running on experiment power which will be distributed by STAR conventional system group. A detailed list of power requirement is presented in Section 2. of this report.

Ventilation System

The temperature and humidity of the DAQ/OP building space should be controlled to insure the proper operation and safety of the equipment and personnel. The maximum heat load escaping from the computers/racks is 80 KW. Additional heat load from heat leaks, lights, facility power outlets etc. should be added to this heat load. The average hall temperature is:

Summer: 75 °F @ 55% RH

Winter: 70 °F @ 55% RH

1.C.4 Building Safety System

The DAQ/OP building should meet all relevant building safety codes. Fire sprinkler, smoke detection, ODH, safety lights, electric ground and regress systems should be available at BOD.

1.D Flammable Gas Mixing House and Gas Bottles Storage Shed

A separate gas mixing house is required to mix the TPC gas. Because the components of the gas mixture (methane) are flammable, the gas house needs to have reasonable temperature control, an explosive gas detection system, an emergency ventilation system and wide walk-ways. Near the gas house there should be a storage shed for flammable liquids. The shed should have a floor above grade with ramps to the mixing house. The shed should have a cover and some walls to protect it from snow and wind. A preferred location for the gas building is to the far end of the assembly building.

1.D.1 Gas House General Utilities Requirements

Electric Power

The electric power in the building should be sufficient to operate the lights, ventilation and mixing and distribution equipment. A detailed list of power requirement is presented in Section 2. of this report.

Ventilation System

The temperature and humidity of the gas mixing building should be controlled to insure the proper operation and safety of the equipment and personnel. The maximum heat load from the equipment is 50 KW. Additional heat loads from heat leaks, transformers, lights, etc. should be added to the heat load. The average temperature is:

Summer: 75 °F @ 55% RH

Winter: 70 °F @ 55% RH

1.D.2 Gas House General Building Safety System

The gas mixing building should meet all relevant building safety codes. Fire sprinkler, smoke detection, ODH, safety lights, emergency ventilation electric ground and regress systems should be available. Instrumentation for the gas safety system will be supplied and installed by the STAR collaboration.

1.E Magnet Power Supply (PS) Building

As currently envisioned, the warm solenoid magnet requires a 2.8 MW power supply. A building is required to house the power supply and its control system. The building should have fire protection and ventilation systems. It is suggested that at least one wall should be movable to facilitate the assembly of the power supply. The building should be located near the WAH to reduce the losses in the conductor and to minimize conductor cost. A preferred location for the gas building is to the far end of the assembly building.

2. Electrical Utilities with a definition of the interface

Power at the site is of two types: primary and secondary. Primary power is specified entirely by STAR, and secondary power is specified by BNL/RHIC in consultation with STAR. The grounding system is specified by STAR.

2.A Definition of power

Site Power is defined as the total power used for STAR at the experimental site. It is divided into primary and secondary power.

Primary power is specified by STAR in terms of quantity, location, usage, and interface with BNL/RHIC. It is divided into three types:

- Facility Power
- Magnet Power
- Experiment Power

Secondary Power is specified by BNL/RHIC in accordance with applicable codes. Input from STAR will also be necessary to fully develop these specifications. Secondary power provides power for CHW, fans, cranes, air conditioning, lighting, and emergency power. Emergency power provides power to light up exit ways, support a safety system, and power some machinery in the event of power failure during their operation.

2.B Primary power

Quantities of the primary power are shown in Table 1. It is divided into the following categories:

- Facility power

  This power is used as For the following::

  - Compressors, pumps and motors for the detector and trolley
  - Gas mixing system
  - Hydraulic equipment used to move the detector and the trolley between the Assembly room and the Wide Angle Hall
  - Welding equipment, drill presses and other equipment used in the mechanical shops

Table 2 shows the quantity and distribution of facility power.

- Supply for Experiments

  This power is used for the subsystem electronics as follows:

  - d.c. supplies and electronic instruments in racks in the trolley
  - d.c. supplies and electronic instruments in a racks in the DAQ/Operations room
  - Computers and workstations in the Operations and Computer rooms
  - Clean room and electronic shop, which also contain electronic equipment for the gas handling and magnet power supply control equipment.

  It is isolated from the rest of the primary power by putting it on separate transformers. These are located in the Assembly room, and the Wide Angle hall. Power is brought to main breakers in the Assembly room for distribution as experimental power.

Table 3 show the quantity and distribution of experiment power.

- Supply for the Magnet

  This power is used for the d.c. power supply of the main and trim coils of the magnet.

  The power for the main magnet is brought in on 13.8 KV. The power for the trim coils is isolated from the rest of the power by putting it on a separate transformer. It is brought to the main breakers in the magnet power supply building for distribution as magnet power.

Table 4 shows the quantity and location of magnet power.

2.C Secondary power

Defined as power for the building and outside equipment, i.e. chillers tower fans, as described below. This power is to be determined by BNL with some input from STAR. Secondary power will be used for:

- General lighting
- The air conditioning system
- Cranes used for lifting components to and from the detector.
- CHW system/cooling towers
- Other
- Emergency power which is used to light up exit ways, support a fire alarm/safety system, and power some machinery in the event of utility power failure during their operation.

This power should be sufficient to satisfy any emergency needs of the equipment in the Gas Mixing House . It should also be brought out to the Assembly building near the main load switches used for trolley power, to energise a Crash-off button.

2. D Power Distribution

The quantities of the different types of Primary power are shown in the Tables below.

Primary Power by type

Table 1

Type of Power	Power (in KW)
Facility	330
Supply for the Experiment	770
Supply for the Magnet	3300
Subtotal	**4400**

In addition to this power, total site power must include the secondary power for chillers, HVAC Towers, water pumps, etc..

Facility Power by location

Table 2

The power factor is not included, and will depend on the motors, pumps etc. used.

Location	Power in KW	Rating in Volts
Wide Angle Hall	50	120 /208/480
Wide Angle Hall (Trolley)	40	120 /208/480
Assembly room	100	120 /208/480
Assembly room (Trolley)	40	120 /208/480
DAQ/Operations room	10	120/208
Computer room	10	120/208
Clean room	10	120 /208
Electrical shop	10	120 /208/480
Mechanical shop	30	120 /208/480
Gas handling room	20	120 /208/480
Magnet Power Supply building	10	120/208
Total	**330**	

Supply for Experiments by location

Table 3

A large portion of the power is used by switching d.c. supplies which generate 60 Hz current harmonics. The power factor for these supplies is about .65, and should be considered in calculating the VA.

Location	Power in KW	Rating in Volts
Wide Angle Hall	50	208
Assembly room (Trolley)	550	480
DAQ/Operations room (racks)	40	208
DAQ/Operations room (cptrs)	40	208
Computer room	50	208
Clean room and Elec. Shop	30	208
Gas handling room	5	208
Magnet Power Supply building	5	208
Total	**770**	

Supply for Magnet by location

Table 4

The power factor of .85 should be used to calculate VA.

Location	Power in KW	Rating in Volts
Power Supply Building	3000	13,800
Power Supply Building	300	480
Total	**3300**	

2.E Grounding system

A ground grid will be provided throughout the facility. This grid will consist of 4/0 cables bolted to the columns of the buildings, and to ground rods. They will also be welded to rebar within the concrete floor. Connection points at specified locations, will be provided for connecting up to this ground plane.

2.F RHIC/STAR Interface for Electrical Utilities

The responsibilities for the electrical interface between STAR and RHIC/BNL are described as follows:

- STAR integration will specify the required power for the experiment and magnet, describing the voltage rating for each type. It is the responsibility of RHIC/BNL to provide this power from the supply network extending up to the panel board or switch-gear, including all transformers and equipment described below, and to situate them as specified by STAR. STAR has the responsibility for distributing the experiment power past this point.
- Facility and Secondary Electrical Power as described earlier is considered to be the responsibility of the RHIC/BNL group.
- RHIC/BNL will also provide a grounding grid according to specifications given by STAR.

2.F.1 Interface with Experiment Power

The interface for power distribution of Experiment Power is shown in Figures 6 and 7, and described below. Except for the power needed in the Wide Angle Hall, this power is taken to the Assembly building for distribution to the various locations called out in Table 3.

<u>Trolley power</u>

The power for the racks on the trolley is 550 KW, taken to two locations as shown in Figure 6. It is required only at one location at a time. This is achieved by using a fusible Load switch for each location, (or a single three position Load switch, including OFF, if available at this rating). It should be possible to use Kirk-locks with these switches, for personnel safety. The panel board at each location will have a main breaker and 8 feeder circuits. The approximate locations of the transformers, load switches, and panel boards are as shown in Figure 6.

<u>Power to other areas</u>

Power for the electronic racks and computers other than on the trolley, is shown in Table 3. It will be taken to 480V/208V dry type, shielded, K rated transformers in the assembly room. Figure 7 shows the interface for power distribution.

Circuits C1 and C2 are isolated from circuits C3 and C4. Each group of circuits are on two 208 V secondaries with their own panelboard. C1 and C2 supply the computers in the Operations and Computer rooms. Circuits C3 and C4 serve the DAQ room racks, the clean room and electrical shop. The Gas mixing house and Magnet Power Supply Building will receive Experiment power on the same circuit as the clean room and the electronic shop. Panelboards should have 300% rated neutrals.

The exact locations for the placement of the equipment for AC power will be determined upon inspection, at a suitable time during the design phase.

A separate transformer and associated panel board will be used for the power in the Wide Angle Hall.

Supply for the Magnet

The power supplied by RHIC for the Magnet Power Supply room is on two circuits, which are isolated from the facility power. One circuit provides 3000 KW @ 13.8 KV, and the other, 300 KW @ 480V. Each power circuit will be terminated in a fusible No-load switch that can be locked by a Kirk-key.

3 Mechanical Utilities Including Interfaces Definition

The following is a preliminary list of general mechanical and electrical utility interfaces between RHIC's provided equipment and STAR equipment.

3.A Chilled Water System

The chilled water provided by RHIC exchanges heat with a modified chilled water closed loop circuit used to cool the detector electronics. RHIC will provide supply and return chilled water manifolds in the assembly building. The chilled water heat load is based on the detector need at phase 1 (baseline). Additional capacity should be added when upgrade system are completed.

Chilled water specifications are:

Supply Temperature = 45 °F

Return Temperature = 55°F - 65°F

Flow Rate =83 gpm

Cooling Capacity =120 KW (about 35 ton of cooling)

Maximum Supply Pressure =125 psi

Return Pressure = Supply pressure less 75 psi

3.B Industrial Cooling Water System

Supply and return manifolds of industrial cooling water are to be provided by RHIC in both the assembly and Wide Angle buildings. The capacity of the system is 50 KW at 80-100 °F supply temperature. The return temperature is expected to be 20°F higher.

3.C Low Conductivity Water System

Low conductivity water (LCW), which is required for the solenoid magnet, will be supplied by RHIC. LCW supply and return manifolds are required in both the WAH and the assembly building. LCW specification will be submitted in a separate report.

Magnet Cooling Parameters

Main coils: 10 coils @ 87.6 gpm	=	876 gpm
Space trim: 2 coils @ 43.8 gpm	=	88
Pole tip trim: 2 coils @ 39.2 gpm	=	79
Total flow for all coils		1043 gpm
Pressure drop across all coils		105 psi
Water volume of all coils		635 gal

Coil Thermal Performance

	T in	**T** out	**T** inc
Main Coils	65 F	85 F	20 F
Space Trim Coils	65 F	89 F	24 F
Pole Tip Trim Coils	65 F	89 F	24 F

3.D HVAC System

RHIC will provide all STAR buildings with conditioned, cooled air. The average building temperature should be kept at about 70°F in winter and 75°F in summer with relative humidity below 55%. The ventilation system should be capable of maintaining a maximum temperature variation within each building of less than 5°F. The heat load of the HVAC system is mostly due to ambient temperature changes. The maximum heat load from STAR related equipment such as motors and machines is about 200 KW.

In addition to general building HVAC requirements, RHIC will provide the electronics trolley with the necessary ventilation supply and return ducts. The supply should be located in both the assembly and Wide Angle buildings. The trolley will return the air back to the halls where it is re-circulated by the main circulation fan. The heat load in the trolley is about 70 KW.

4. Interfaces with Accelerator System

Detailed discussion of this interface will be presented before Title 2 activities.

4.1 Mechanical Systems Interfaces

The STAR detector and the accelerator system mechanically interface in the hall at the beampipe and at approximately +/- 17 meters from the IP where the veto calorimeters will be placed. Details of these interfaces will be presented before Title 2 activities.

4.2 Computing/Communication Systems Interfaces

The Ethernet and FDDI network will be brought to a suitable location which will be determined after examination of the facility. This installation will be done by RHIC/BNL.

The accelerator clock signals will be brought to a suitable location which will be determined after examination of the facility. This installation will be done by RHIC/BNL.