

FOR RECOMMENDATION

PUBLIC

OPEN SESSION

TO: Planning & Budget Committee

SPONSOR: Professor Scott Mabury, Vice President, University Operations

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PRESENTER: Christine Burke, Director, Campus and Facilities Planning

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DATE: September 09, 2015 for September 17, 2015

AGENDA ITEM: 6

ITEM IDENTIFICATION:

Capital Project: Report of the Project Planning Committee for the High Pressure Combustion Research Facility, University of Toronto Institute for Aerospace Studies, Faculty of Applied Science and Engineering

JURISDICTIONAL INFORMATION:

Pursuant to section 4.2.3. of the Committee's terms of Reference, "...the Committee considers reports of project planning committees and recommends to the Academic Board approval in principle of projects (i.e. space plan, site, overall cost and sources of funds)."

Under the Policy on Capital Planning and Capital Projects, "...capital projects over \$3 million and up to \$10 million will be considered by the Planning and Budget Committee for projects at the St. George campus and by the respective Campus Affairs Committees and Campus Councils for projects at University of Toronto Mississauga and University of Toronto Scarborough and recommended to the Academic Board for consideration. It is expected that such projects will be placed on the Board's consent agenda and be confirmed by the Executive Committee of the Governing Council. Execution of such projects is approved by the Business Board."

GOVERNANCE PATH:

A. Project Planning Report – Project Scope, Total Project Cost, and Sources of Funding

- 1. Planning and Budget [for recommendation] (September 17, 2015)**
2. Academic Board [for approval] (October 01, 2015)
3. Executive Committee [for confirmation] (October 21, 2015)

B. Execution of the Project

1. Business Board [for approval] (September 21, 2015)

PREVIOUS ACTION TAKEN:

This High Pressure Combustion Research Facility (HPCRF) project at University of Toronto Institute for Aerospace Studies (UTIAS) is the result of a successful Canadian Foundation for Innovation (CFI) / Ontario Research Fund (ORF) application made in the 2012 round of Faculty of Applied Science and Engineering (FASE) submissions and awarded in 2013. Design work has been in progress since late 2013, following CaPS approval in November, 2013, to proceed with consultant selection and preliminary design. An increase in design fees was approved by CaPS in March, 2015. Recently estimated at a Total Project Cost over \$3 million, the project is being brought forward through governance for approval.

HIGHLIGHTS:

Faculty of Applied Science and Engineering supports a vibrant research community with Sustainability being one of the key research foci. Natural Environment, Urban and Industrial Environments, Infrastructure, and Sustainable Energy are included in this over-arching research theme. Engineers have long been aware of the impact of their activities on the environment, including reducing the impact of aviation pollutions, extracting natural resources and minerals, monitoring the earth from micro and nano satellites, and distributing energy efficiently.

Combustion science and technology remain one of the most challenging technological fields. The High Pressure Combustion Research Facility (HPCRF) project will provide the means to advance combustion science and facilitate the development of technologies that can revolutionize the future design of gas turbines. The anticipated advancement of gas turbine technology will directly benefit aircraft propulsion systems as well as industrial energy production. The resulting knowledge and technologies will improve the quality of life through reduced pollutant emissions and fuel consumption, and will enhance the global competitiveness of Canadian gas turbine industries.

This research facility will be accommodated at the Aerospace Building in Downsview. It will be necessary to renovate 188 nasm of existing space to accommodate a new research lab and lab support space. The project scope includes the design and installation of significant fixed equipment infrastructure to support the research activities of 2.5 faculty, 2 post-doctoral researchers, 5 graduate students, and 2 undergraduate students. The facility will be operational by August, 2016.

Secondary Effects

There are no secondary effects anticipated for the proposed project. The construction area will be isolated from other building occupants for the duration of the project and it is assumed that all existing adjacent areas/rooms will function as normal. As well, the proposed project will not impact any other projects being executed in the sector.

Schedule

Project milestones for the proposed project are identified as:

| | |
|-----------------|--|
| September, 2015 | CaPS Executive (Cycle 1) approval |
| September, 2015 | Schematic design completion |
| October, 2015 | Governing Council (Cycle 1) approval |
| November, 2015 | Design development and contract documents completion |
| November, 2015 | Tender award |
| January, 2016 | Mobilization and construction start |
| August, 2016 | Substantial completion |

FINANCIAL AND PLANNING IMPLICATIONS:

Discussion of overall costs and sources of funds can be found in the *in camera* document for this project.

RECOMMENDATIONS:

Be It Recommended to the Academic Board:

1. THAT the Report of the Project Planning Committee for the High Pressure Combustion Research Facility, University of Toronto Institute for Aerospace Studies, Faculty of Applied Science and Engineering, dated August 26, 2015, be approved in principle, and;
2. THAT the project scope to accommodate the High Pressure Combustion Research Facility Renovation of 188 net assignable square metres (nasm), be approved in principle, to be funded by Canadian Foundation for Innovation (CFI) funds, Ontario Research Fund (ORF) funds and Faculty of Applied Science and Engineering (UTIAS) Operating Funds.

DOCUMENTATION PROVIDED:

- Report of the Project Planning Committee for the High Pressure Combustion Research Facility, University of Toronto Institute for Aerospace Studies, Faculty of Applied Science and Engineering, dated August 26, 2015.

**Report of the Project Planning Committee for the
High Pressure Combustion Research Facility
University of Toronto Institute for Aerospace Studies
Faculty of Applied Science and Engineering**

August 26, 2015

University of Toronto
Facilities & Infrastructure Planning, Faculty of Applied Science and Engineering

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I. Executive Summary

The High Pressure Combustion Research Facility (HPCRF) project is the result of a successful Canadian Foundation for Innovation (CFI) / Ontario Research Fund (ORF) application made in the 2012 round of the Faculty of Applied Science & Engineering (FASE) submissions and awarded in 2013. This research facility will provide the means to advance combustion science and facilitate the development of technologies that can revolutionize the future design of gas turbines. The anticipated advancement of gas turbine technology will directly benefit aircraft propulsion systems as well as industrial energy production. Combustion science and technology remain one of the most challenging technological fields. These challenges become even more formidable at the elevated pressures at which gas turbines operate.

FASE supports a vibrant research community. One of our key research foci is Sustainability. Natural Environment, Urban and Industrial Environments, Infrastructure, and Sustainable Energy are included in this over-arching research theme. Engineers have long been aware of the impact of their activities on the environment, including reducing the impact of aviation pollutions, extracting natural resources and minerals, monitoring the earth from micro and nano satellites, and distributing energy efficiently.

The research program that will be conducted at the HPCRF will enable improved understanding and control of high-pressure combustion, which is crucial for the design of next generation gas turbines and other high-pressure combustion devices. The resulting knowledge and technologies will improve the quality of life through reduced pollutant emissions and fuel consumption, and will enhance the global competitiveness of Canadian gas turbine industries.

This research facility will be accommodated at the Aerospace Building in Downsview. It will be necessary to renovate approximately 188 nasm of existing space. The project scope of work includes the design and installation of significant fixed equipment infrastructure to support the research activities of 2.5 faculty, 2 post-doctoral researchers, 5 graduate students, and 2 undergraduate students. It is anticipated that the facility will be operational in August, 2016.

II. Project Background

a) Membership

Steve Miszuk, Director- Facilities & Infrastructure Planning, FASE (Chair)
Omer Gulder, Professor, UTIAS
Adam Steinberg, Assistant Professor, UTIAS
Jeff Cook, Building Services Officer, UTIAS
Qiang An, Graduate Student, UTIAS
Patricia Piwowar, Senior Planner, Campus & Facilities Planning

b) Terms of Reference

1. Make recommendations for the space program and functional layout and renovation required to accommodate the High Pressure Combustion Research Facility (HPCRf) in the UTIAS building at Downsview, as it relates to the Faculty's academic plan.
2. Demonstrate that the proposed space program will take into account the Council of Ontario Universities and the University's own space standards.
3. Determine any secondary effects of the project including staging and sequencing in order for facilities to remain operational during renovations.
4. Identify a schedule to complete the project.
5. Identify the Total Project Cost (TPC) and costs associated with secondary effects if any.
6. Identify all funding sources for the proposal.

c) Background Information

This HPCRf project is the result of a successful CFI/ORF application made in the 2012 round of FASE submissions and awarded in 2013. Design work has been in progress since late 2013, following CaPS approval in November, 2013, of a TPC of \$321,690 for design fees. The TPC for design fees was increased to \$470,434 and approved by CaPS in March, 2015.

Note that the original project name in the CaPS approval was the High Pressure Blow-Down Facility (HPBDF) but this type of experiment was not feasible within the available budget. The experiment was redesigned to a constant-flow process, rather than the blow-down process, hence the name change for the facility.

d) Statement of Academic Plan

The Faculty of Applied Science & Engineering supports a vibrant research community, situated within a research-intensive, pre-eminent university. The Faculty members diligently raise funding through Tri-council, provincial and industry programs, participate in major research initiatives both nationally and internationally, build and lead spin-off companies, and collaborate with key industrial sectors. Their extended research community includes research associates, undergraduate and graduate students, postdoctoral researchers and laboratory technicians. A number of our research initiatives are interdisciplinary and involve faculty members from multiple departments across the University of Toronto.

One of the key research foci is Sustainability. Natural Environment, Urban and Industrial Environments, Infrastructure, and Sustainable Energy are included in this over-arching research theme. Engineers have long been aware of the impact of their activities on the environment, including reducing the impact of aviation pollutions, extracting natural resources and minerals, monitoring the earth from micro and nano satellites, and distributing energy efficiently.

The University of Toronto Institute for Aerospace Studies (UTIAS) is one of the foremost research and teaching facilities of its kind in the world, and is without question the best aerospace department in Canada. UTIAS aspires to be a leading global centre of excellence in research toward technologies to reduce the impact of aircraft on climate change.

The research program that will be conducted at the HPCRf will enable improved understanding and control of high-pressure combustion, which is crucial for the design of next generation gas turbines and other high-pressure combustion devices. This research facility will provide a unique opportunity to create a strong and vibrant research environment that will attract excellent young researchers. The resulting knowledge and technologies will improve the quality of life through reduced pollutant emissions and fuel consumption, and will enhance the global competitiveness of Canadian gas turbine industries.

e) Space Requirements

The UTIAS building at Downsview, including the Microsatellite Science & Technology Centre completed in 2012, occupies approximately 5294 nasm of interior space (7,232 gross square meters). The space requirements for the HPCRf are governed by the size of the fixed equipment needed to produce the high temperature and high pressure air required for the combustion experiments, as well as the size of the test chamber itself, where the combustion experiments will be conducted.

When fully functional, the HPCRf will serve the following existing faculty, researchers and students:

| Use (COU Category) | Count | Space Factor | COU Generated Space (NASM) |
|----------------------------------|-------|--------------|----------------------------|
| RESEARCH LABORATORY (3.0) | | | |
| Faculty | 2.5 | 30 | 75 |
| Post-Doctorals | 2 | 0.5 (30) | 30 |
| Graduate Students | 5 | 0.5 (30) | 75 |
| Undergraduates | 2 | 0 | 0 |
| | | Total | 180 |

III. Project Description

a) Vision Statement

This research facility will provide the means to advance combustion science and facilitate the development of technologies that can revolutionize the future design of gas turbines. The anticipated advancement of gas turbine technology will directly benefit aircraft propulsion systems as well as industrial energy production. Combustion science and technology remain one of the most challenging technological fields. These challenges become even more formidable at the elevated pressures at which gas turbines operate.

b) Space Program and Functional Plan

188 nasm of space is currently available to accommodate the space requirements of the HPCRf and includes rooms 150, 150E, 142, and part of room 140 (refer to the Existing Building Floor Plan in

Appendix A and the Proposed Project Floor Plan in Appendix B). Space in room 140 is available due to the downsizing of the former machine shop which supported research activities. The remaining rooms have become available following the recent MSTC addition coming online, allowing a rationalization of space use at UTIAS.

| Use (COU Category) | Count | Space Factor | Proposed Space (NASM) |
|----------------------------------|-------|--------------|-----------------------|
| RESEARCH LABORATORY (3.0) | | | |
| Research Laboratory (3.1) | 1 | 121 | 121 |
| Laboratory Support (3.2) | 1 | 67 | 67 |
| Exterior Equipment Pad (3.2)* | 1 | 70 | |
| | | Total | 188 |

* Not included in total Proposed Space as it is exterior space.

The Research Lab will house the test chamber, instrumentation controls and diagnostic equipment. The Lab Support space will house fixed equipment in support of the test chamber. The Exterior Equipment Pad will be used for oil tank and compressed gas cylinder storage. It is sized to support future expansion of research activities. All equipment and support infrastructure (with the exception of the exterior equipment) will be housed within the lab and support space, with a gross to net area ratio of 1:1. There are no non-assignable spaces in the proposed project scope.

The relationship between the Research Lab, Lab Support and and Exterior Equipment Pad is shown in the Site Plan drawing in Appendix C.

Room Data Sheets are not available for the proposed project as the scope of work required relates entirely to the fixed equipment for experimentation.

c) **Building Considerations**

- Standards of construction for this project will conform to the University’s Design Standards
- The project includes a combination of intense mechanical and electrical infrastructure upgrades, with moderate architectural renovation. The building components and systems to be considered for the project include but are not limited to: HVAC, electrical power, and fire protection
- Equipment will be selected to ensure that new electrical loading will fall within existing building electrical capacity, in consultation with Facilities & Services
- Research lab and support space will be acoustically isolated from the adjacent areas in recognition of the sound-generating characteristics of the equipment and the experimental processes
- Generating high-pressure compressed air will be conducted outside of the normal operating hours of UTIAS to minimize the acoustic impact on adjacent facilities and to spread the electrical loading to off-peak hours
- The project design will conform to all applicable codes and regulations, including Environmental Health & Safety guidelines

- The University of Toronto is committed to ensure that its buildings and services are accessible to persons with disabilities. Compliance with the University's Barrier Free Accessibility Design Standards is required for all new construction and renovation projects at the St. George campus. Neither the ODA nor the University require full adherence to the standard. For renovation projects, particularly of older buildings, there may be some recommendations that are very difficult or impossible to implement. Design teams must provide written explanation in the event of non-compliance.
- The proposed project's design and construction should be driven by sustainable initiatives as appropriate and feasible in terms of design, construction and operation. In particular, innovative and alternative choices, should be considered when decisions are made about design, processes and products that influence resource use (e.g., energy, water, materials) and other environmental impacts (e.g., indoor air quality, lighting, waste management)
- A Hazardous Building Materials Inventory Report will be generated for the project area, which is anticipated to include asbestos containing materials and lead paint
- Minimal demolition involving the removal of demising partitions will be included in the project
- There are no phasing requirements anticipated for this project
- The construction area for the project will be isolated from other building occupants for the duration of the project and will not affect normal use of existing program to remain

d) Site Considerations

- It is not anticipated that the small exterior equipment pad will require the Site Plan to be revisited with the City
- The equipment pad will be situated to avoid impacting the neighboring recreational facilities, while maintaining the access road to the Library Storage facility to the east of UTIAS
- The current Certificate of Approval from the Ministry of the Environment for air pollutants will need to be amended to reflect the exhaust from the new research lab experiment
- The proposed project will not impact any other projects moving ahead in the sector

e) Infrastructure Considerations

- The project will be designed within the limits of the existing building infrastructure with respect to utilities
- The access road and pedestrian pathways will be maintained throughout the project

f) Secondary Effects

- There are no secondary effects anticipated.

g) Schedule

Project milestones for the proposed project are identified as:

| | |
|-----------------|--|
| September, 2015 | CaPS Executive (Cycle 1) approval |
| September, 2015 | Schematic design completion |
| October, 2015 | Executive Committee (Cycle 1) confirmation |
| November, 2015 | Design development and contract documents completion |
| November, 2015 | Tender award |
| January, 2016 | Mobilization and construction start |
| August, 2016 | Substantial completion |

IV. Resource Implications

a) Total Project Cost Estimate

The total estimated cost for the project includes estimates or allowances for:

- construction costs* (assuming a lump sum type of tender to qualified general contractors in the month of October, 2015)
- contingencies
- taxes
- hazardous waste removal**
- demolition
- permits and insurance
- Professional fees, architect, engineer, miscellaneous consultants, project management.

* Includes fixed equipment costs that form the basis of the lab infrastructure

** Included as part of construction cost

b) Operating Costs

The current annual operating costs at UTIAS are \$180/nasm, paid for by the Faculty of Applied Science and Engineering. There will be an increase in electrical operating costs for the building directly related to the utilization of the major new experimental equipment but at this point it is not possible to estimate what that change will be as the equipment selection is not yet final, nor is the duration of running the experiments known. However, the equipment will be operated at off-peak hours to mitigate the cost of electricity used and operating costs will continue to be paid for by FASE.

c) Other Related Costs/Issues

When the project was originally submitted to the CFI/ORF call for proposals in 2012, all of the equipment was identified separately from the construction costs. Now that much of the major equipment is blended into the construction cost, the revised budget allocations for construction and equipment must be resubmitted and accepted by the granting agencies. This review will take place during the tender period of the project.

d) Funding Sources

The project will be funded as follows:

| | |
|--|-------|
| Canadian Foundation for Innovation (CFI) funds | 47.5% |
| Ontario Research Fund (ORF) funds | 47.5% |
| Faculty of Applied Science and Engineering (UTIAS) Operating Funds | 5.0% |

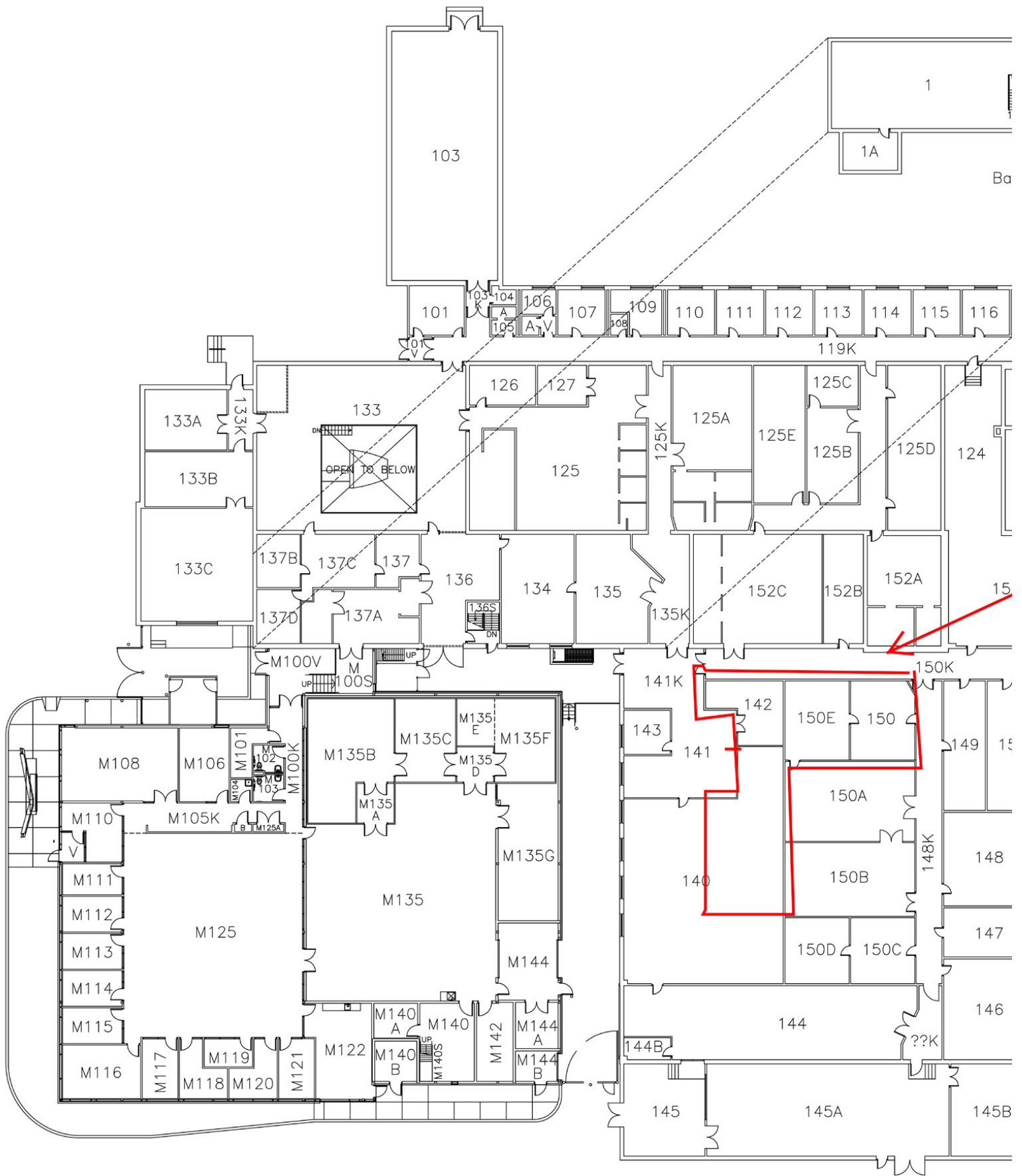
APPENDICES:

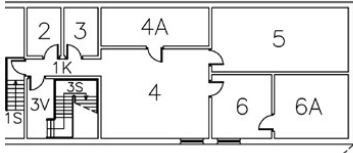
- A. Existing Aerospace Building Floor Plan
- B. Proposed Project Floor Plan
- C. Site Plan
- D. HPCRF Process and Instrumentation Diagram
- E. Total Project Cost Estimate (on request to limited distribution)

Appendix A

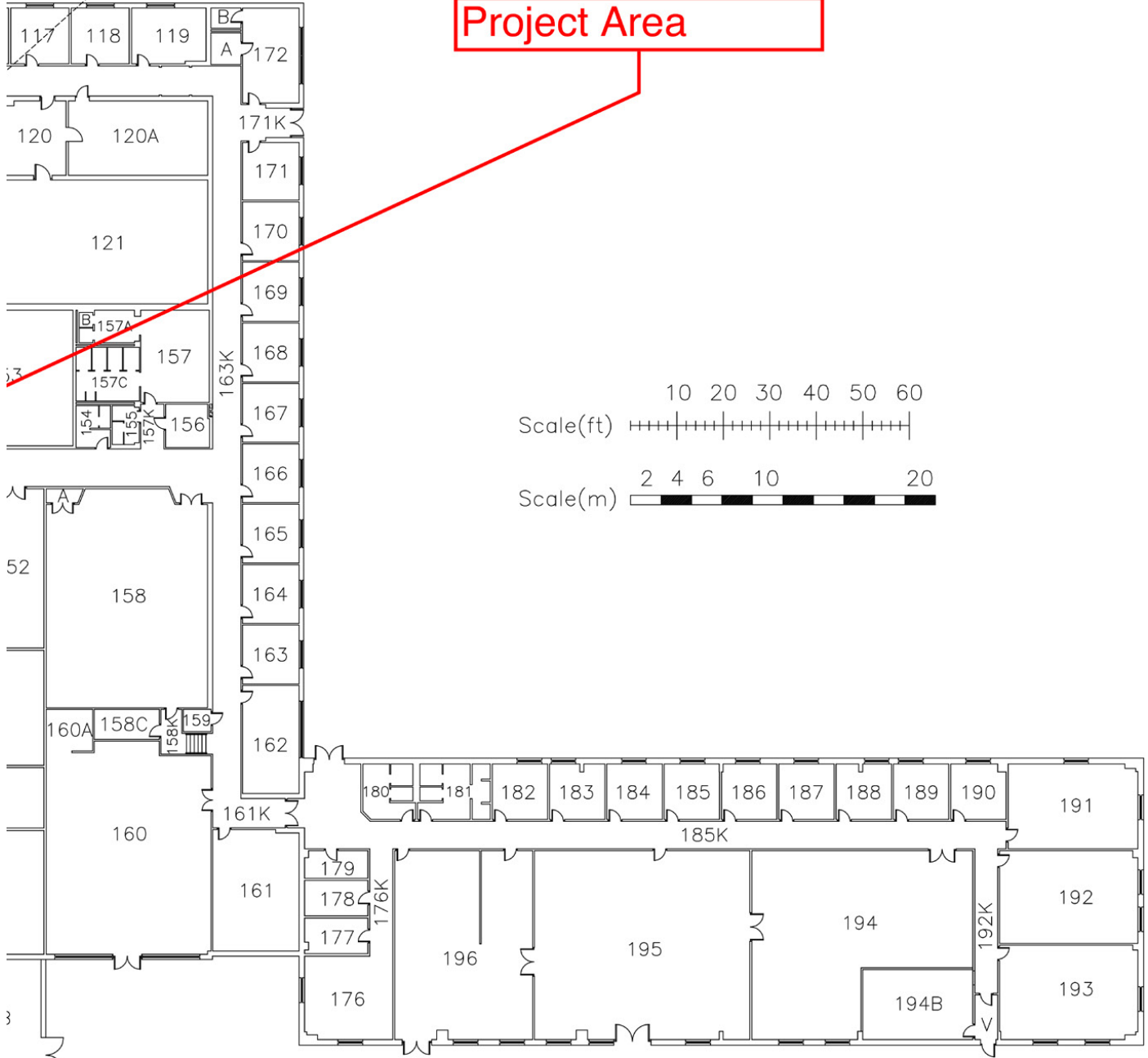
Existing Aerospace Building Floor Plan

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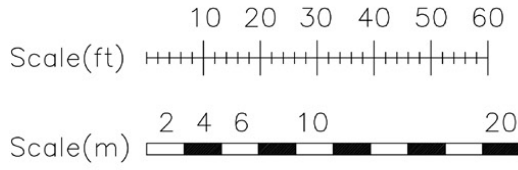




Basement Below

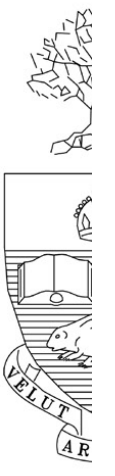


Project Area



University of Toronto

Campus Facilities Plan



Institute for Aerospace Studies

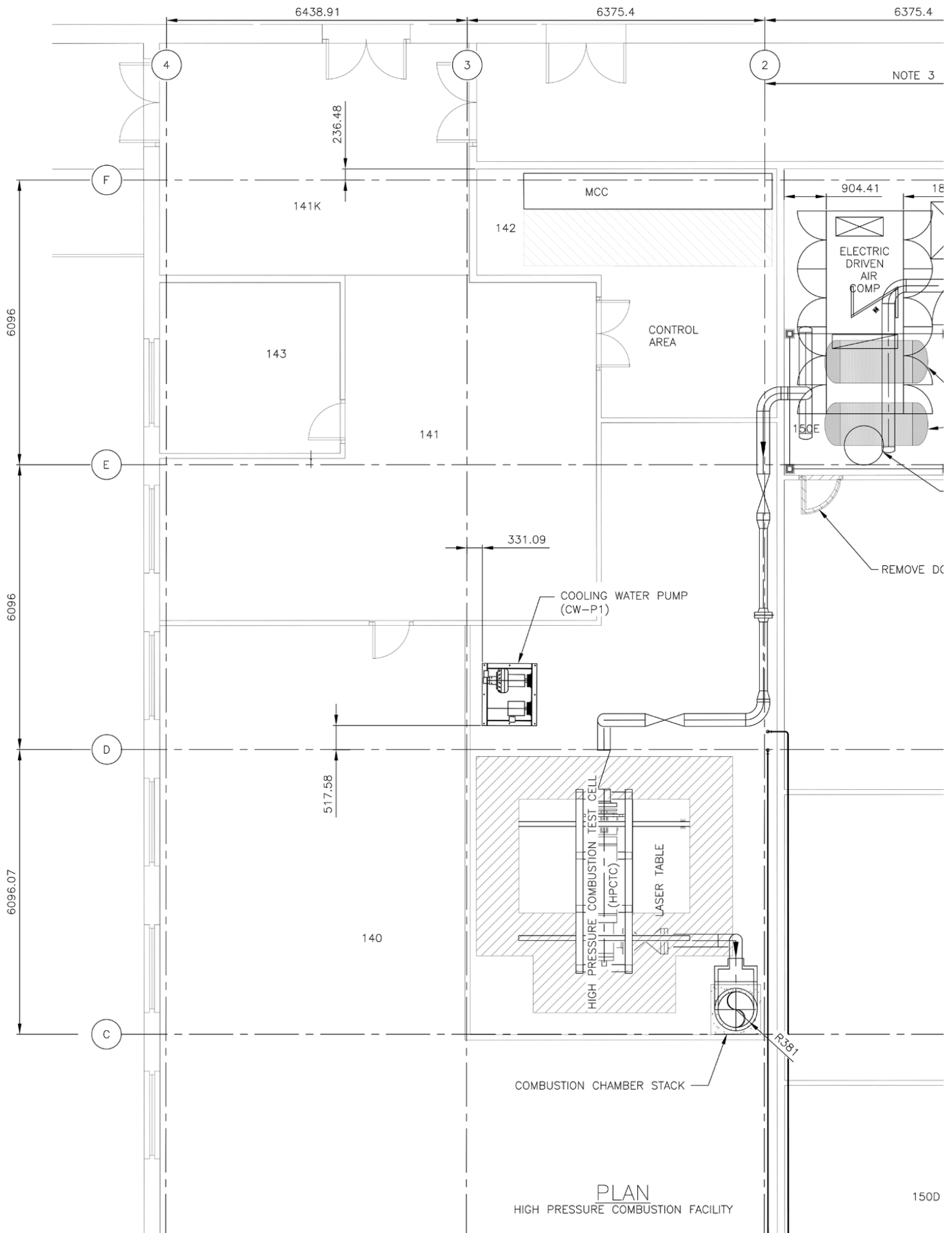
Building 1st

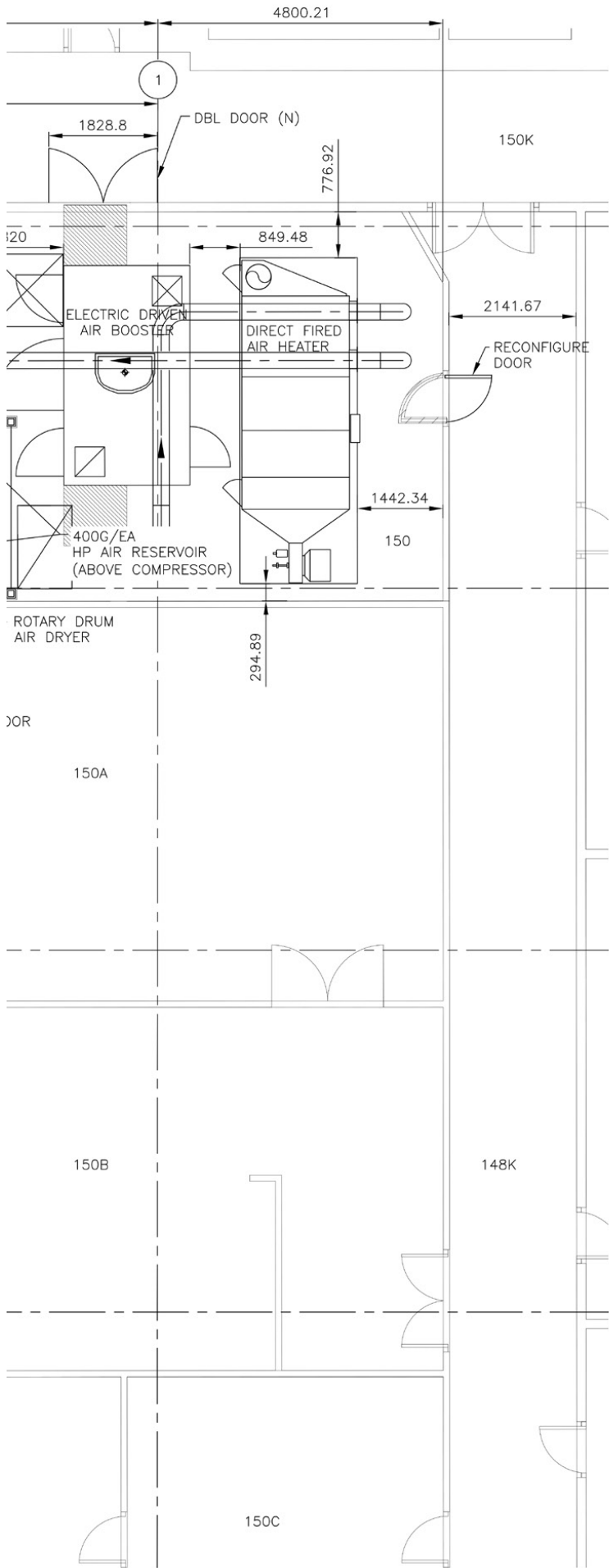
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DWC

Appendix B

Proposed Project Floor Plan





NOTES:

1. GENERAL NOTES AND REFERENCES (310.01-M100)
2. SCALE AS NOTE
3. ROOM 150/150E NORTH WALL TO BE REMOVED FOR RIGGING OF EQUIPMENT. REBUILD WALL ACCORDANCE TO STRUCTURAL REQUIREMENTS
- 4.

DRAWING REFERENCE:
ROOF PLAN.....310.01-M1001

HPBD TEST
CELL BOUNDARY

GENERAL
MAINTENANCE
AREA



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 1100 South Service Rd., Suit # 417
 Stoney Creek, ON L8E 0C5
 www.arcengineering.ca

| REV. | DESCRIPTION | DATE |
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FOR INFORMATION 08-18-2015
 REVISIONS AND ISSUES RECORD
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PROJECT TITLE
 UNIVERSITY OF TORONTO
HIGH PRESSURE COMBUSTION RESEARCH FACILITY
 AT UTIAS IN DOWNSVIEW

4925 Dufferin St, Toronto, On
 DRAWING SHEET TITLE
HIGH PRESSURE COMBUSTION FACILITY

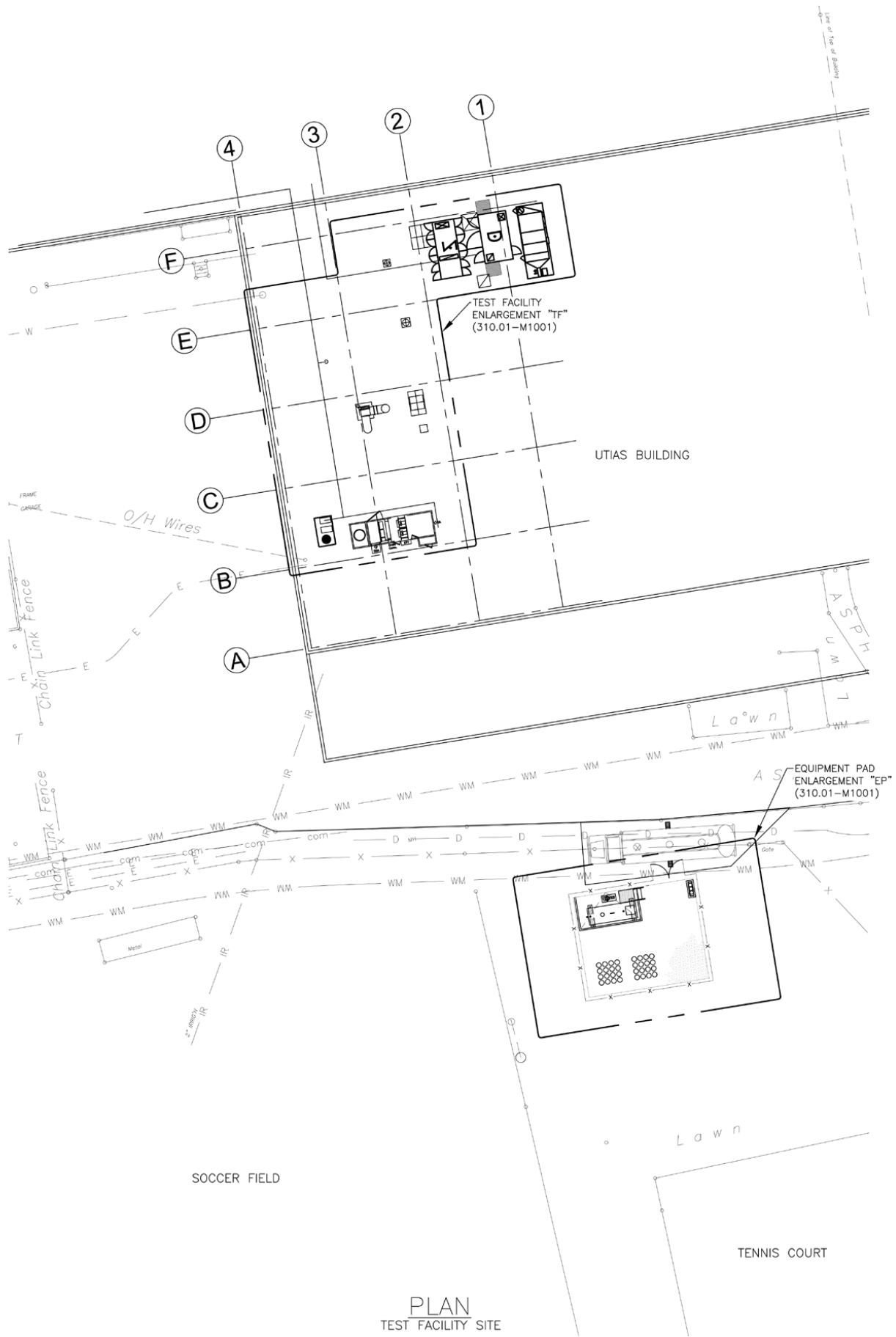
**GENERAL ARRANGEMENT
EQUIPMENT LOCATION**

SCALE 1:50
 DRAWN BY GMMeadville DATE 04-19-2015
 DATE PRINTED 18-Aug-15

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| UNIVERSITY PROJECT NUMBER P049-13-051 | NORTH POINT  |
| DRAWING NUMBER 310.01-M101A | REV. NUMBER E |

Appendix C

Proposed Project Site Plan



PLAN
TEST FACILITY SITE



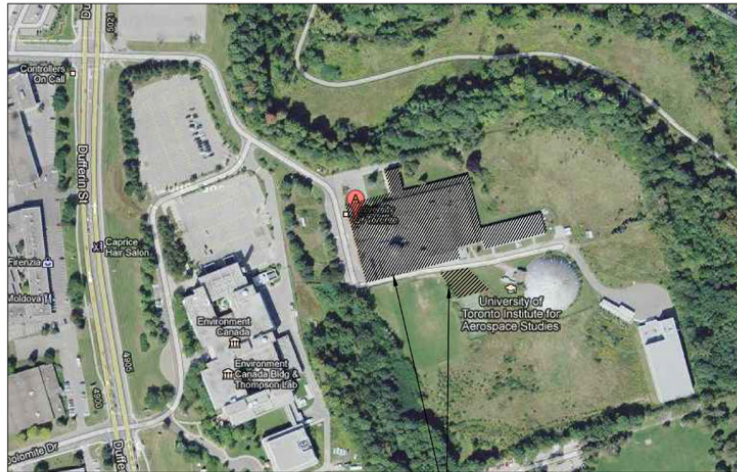
University of Toronto

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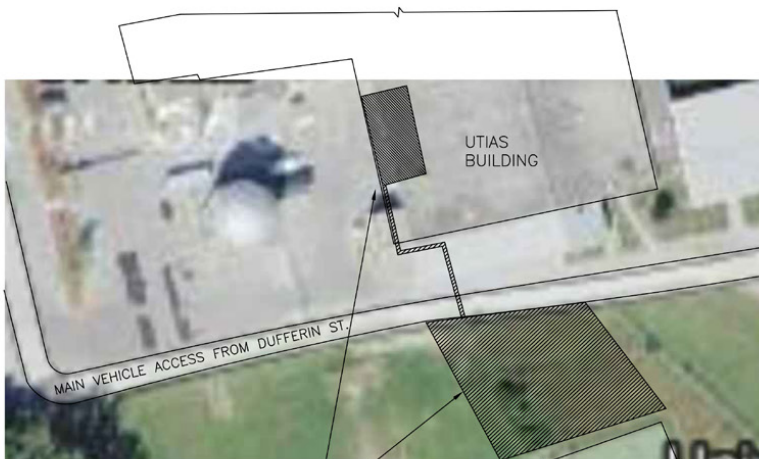
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AREA OF WORK

SITE PLAN



AREA OF WORK

KEY PLAN

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REVISIONS AND ISSUES RECORD

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PROJECT TITLE

UNIVERSITY OF TORONTO
HIGH PRESSURE COMBUSTION RESEARCH FACILITY
AT UTIAS IN DOWNSVIEW

4925 Dufferin St, Toronto, On

DRAWING SHEET TITLE
HIGH PRESSURE COMBUSTION FACILITY

SITE GENERAL ARRANGEMENT

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| DATE PRINTED 18-Aug-15 | |

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Appendix D

HPCRF Process Diagram

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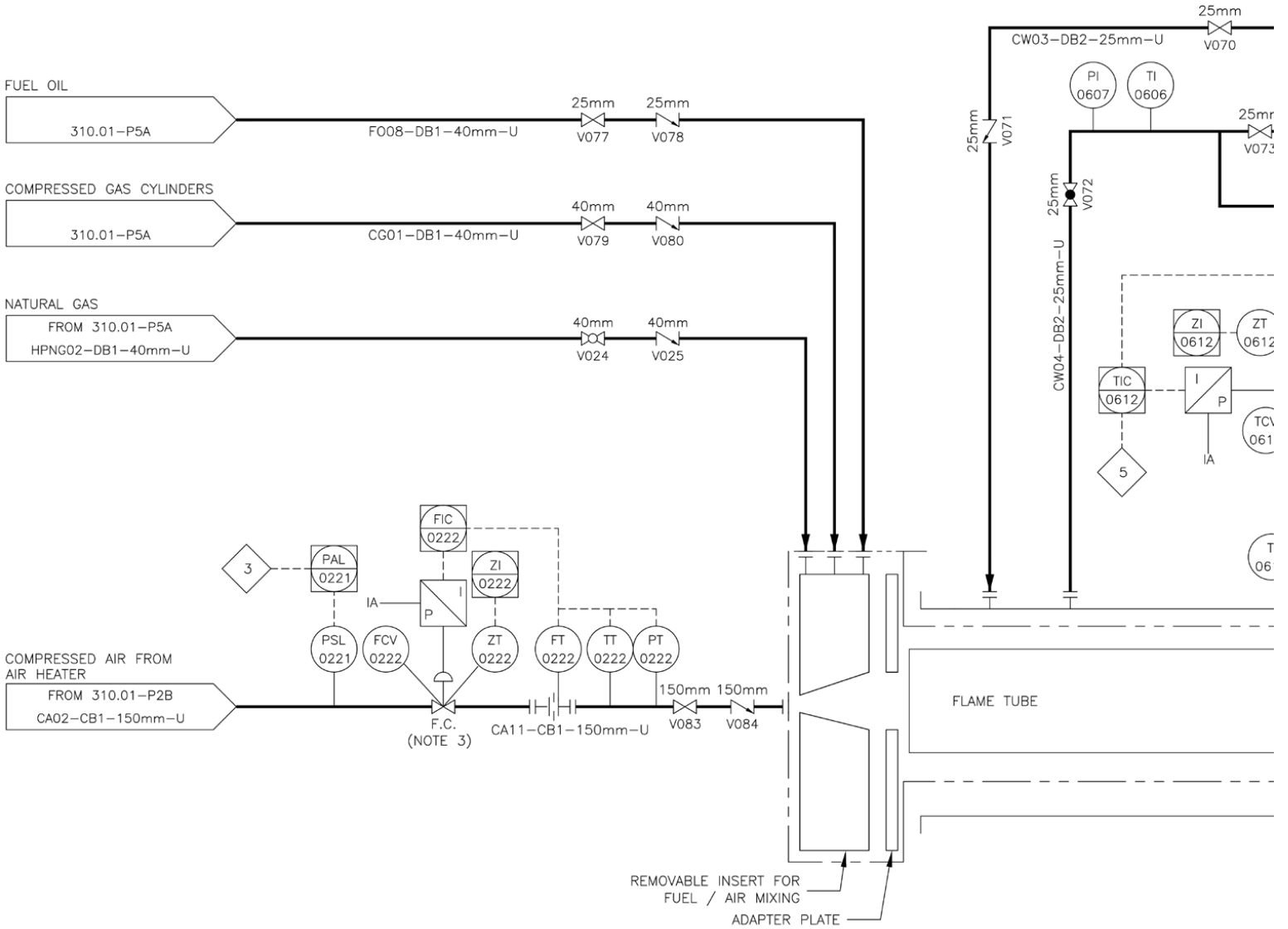
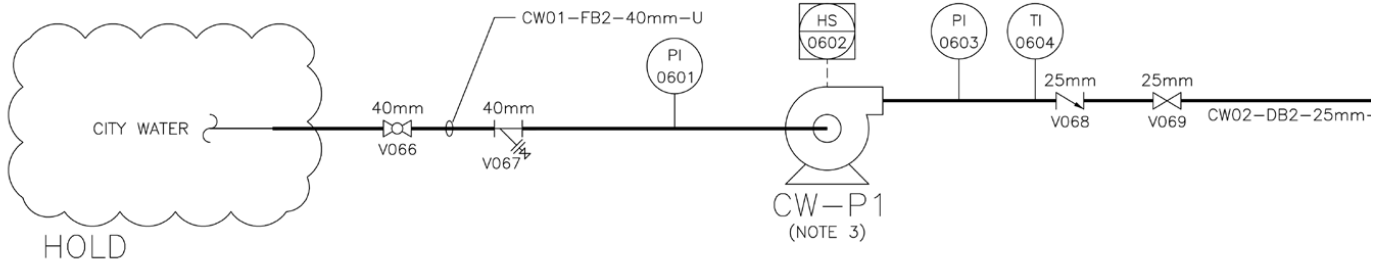
SERVICE: COOLING WATER
CAPACITY: 76 LPM (20 GPM)
TDH: 564m (1848 FEET)
HORSEPOWER: 19kW (25HP)
ELECTRIC: 600V/3PH/60HZ

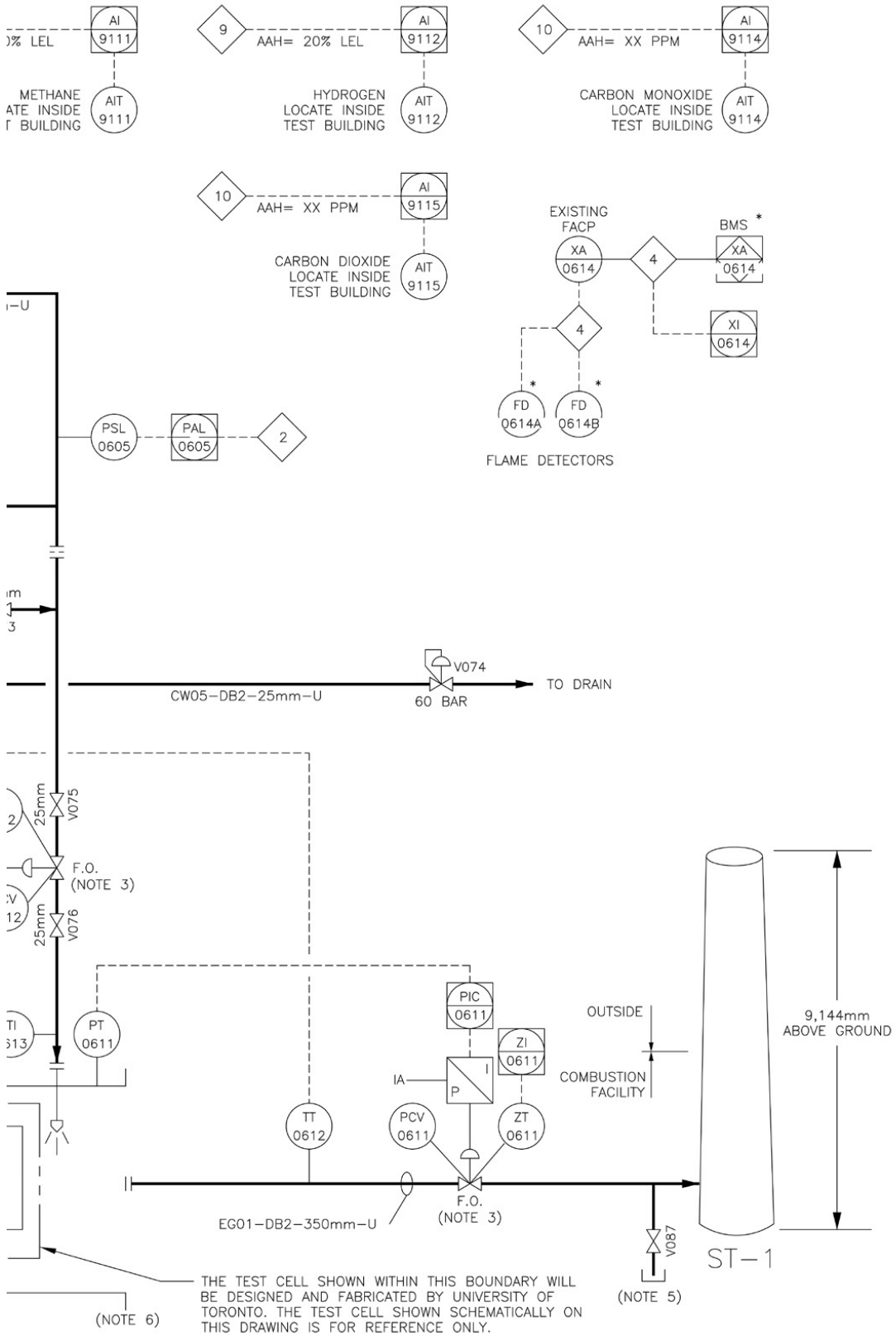
ST-1

SERVICE: EXHAUST GAS
DIAMETER: 762mm (2.5')
HEIGHT: 9,144mm (30')

9
AAH= 20'

LOCA
TEST





University of Toronto

255 McCaul Street, 4th Floor, Toronto, Ontario M5T 1W7

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| REV. | DESCRIPTION | DATE |

REVISIONS AND ISSUES RECORD

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PROJECT TITLE
 UNIVERSITY OF TORONTO
HIGH PRESSURE COMBUSTION RESEARCH FACILITY
 AT UTIAS IN DOWNSVIEW

4925 Dufferin St, Toronto, On

DRAWING SHEET TITLE
PROCESS AND INSTRUMENT DIAGRAM

COMBUSTION SYSTEM

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| SCALE | AS NOTED |
| DRAWN BY KWCho | DATE 03-15-2014 |
| DATE PRINTED 19-Aug-15 | |

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