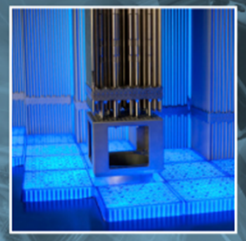
DEVELOPMENT & DESIGN CONSIDERATIONS

POST IRRADIATION EXAMINATION HOT CELLS FOR McMASTER UNIVERSITY HAMILTON, ONTARIO, CANADA



HOT CELLS EUROPE 2011

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Dr. John Luxat, McMaster University
Valerie Walker, Merrick & Company

May 24, 2011

PRESENTATION AGENDA

- INITIAL CONSIDERATIONS
  - BACKGROUND
  - LOCATION
  - SCOPE OF SPECIMENS ACCEPTED AND EXAMINATIONS PERFORMED
- DESCRIPTION OF CONCEPTUAL DESIGN
- DISCUSSION OF SOME KEY CHALLENGES AND DECISIONS

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BACKGROUND

- CENTRE FOR ADVANCED NUCLEAR SYSTEMS
- RESEARCH INFRASTRUCTURE BEING ESTABLISHED AT McMASTER FUNDED BY FEDERAL AND PROVINCIAL GOVERNMENT GRANTS
  - PIE FACILITY (FOCUS OF THIS PRESENTATION)
  - ATOMISTIC LEVEL MATERIAL CHARACTERIZATION (SEM/FIB, TEM, 3-D ATOM PROBE)
    - ALLOY DEVELOPMENT + SCW MATERIALS TESTING
    - NUCLEAR SAFETY THERMALHYDRAULICS TESTING FACILITY

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ROLES & RESPONSIBILITIES

- McMASTER UNIVERSITY, HAMILTON, ONTARIO, CANADA, IS THE OWNER/OPERATOR
  - ESTABLISHES THE FACILITY LOCATION
  - JOINTLY ESTABLISHES THE FUNCTIONAL & OPERATIONAL REQUIREMENTS
  - REVIEWS AND APPROVES DESIGN
- MERRICK & COMPANY, AURORA, COLORADO, UNITED STATES, IS THE ARCHITECT/ENGINEER
  - ATKINSON ENGINEERING INC., HAMILTON, ONTARIO, WAS A/E PARTNER
  - JOINTLY ESTABLISHES THE FUNCTIONAL & OPERATIONAL REQUIREMENTS
  - PREPARES THE CONCEPTUAL DESIGN
  - COMPILES THE COST ESTIMATE AND CONSTRUCTION SCHEDULE

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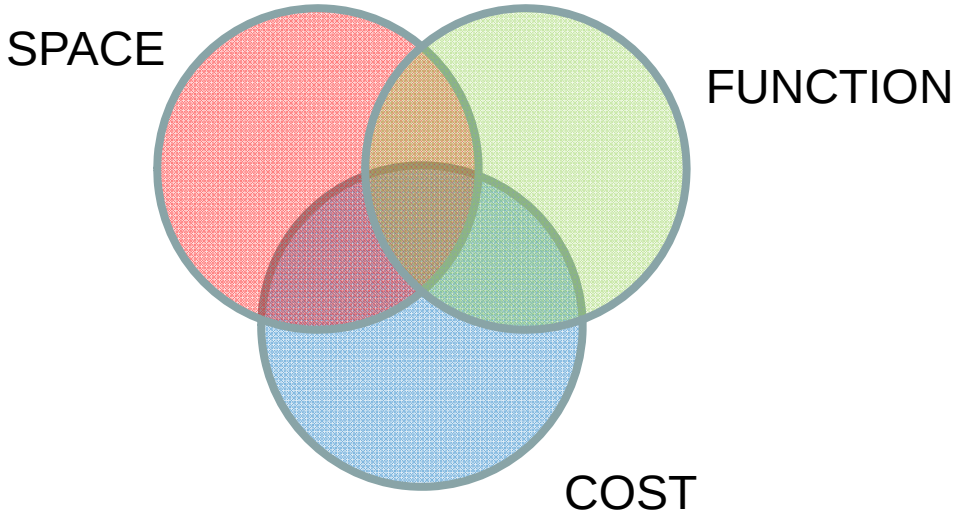
FAMILIAR TUG-OF-WAR



SUCCESSFUL DESIGN HAS TO FIT
INTO THE INTERSECTION OF AVAILABLE SPACE,
REQUIRED FUNCTIONS, AND
ACCEPTABLE COSTS

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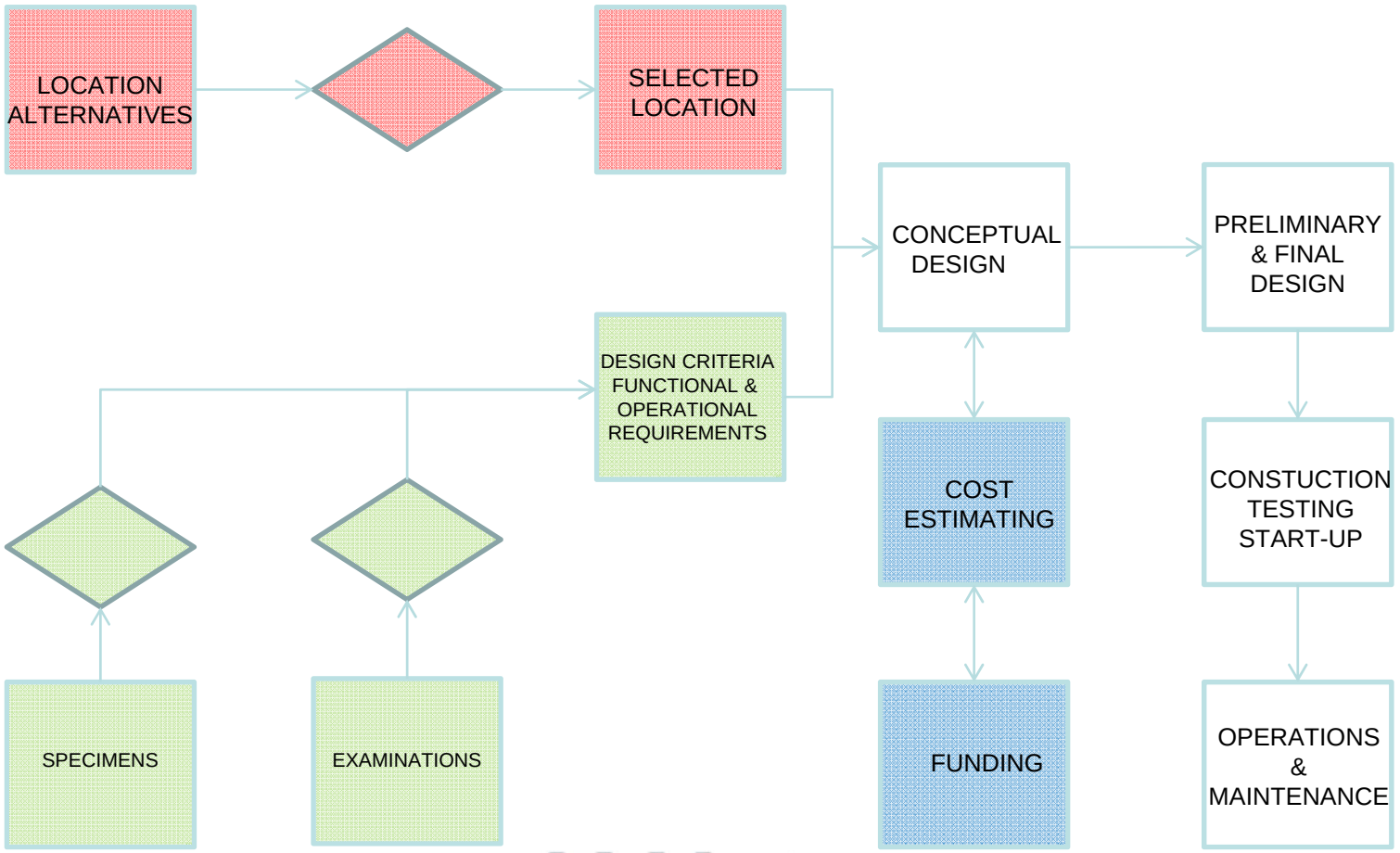
DESIGN STEPS



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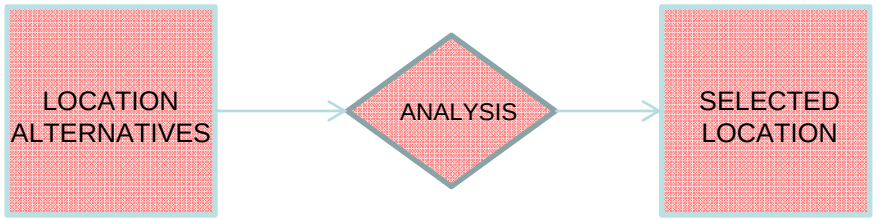
LOCATION SELECTION
McMASTER UNIVERSITY



SELECTION:
ROOM 105 Tandem Accelerator Building

- ALTERNATIVES
  - GREENFIELD – ON CAMPUS
  - GREENFIELD – OFF CAMPUS
  - WITHIN EXISTING FACILITY
- BASIS OF ANALYSIS
  - WITHIN EXISTING REACTOR LICENSE
  - AMENDMENT OF EXISTING LICENSE
  - NEW PERMITTING AND LICENSING
  - COST OF SITE ACQUISITION OR MODIFICATION

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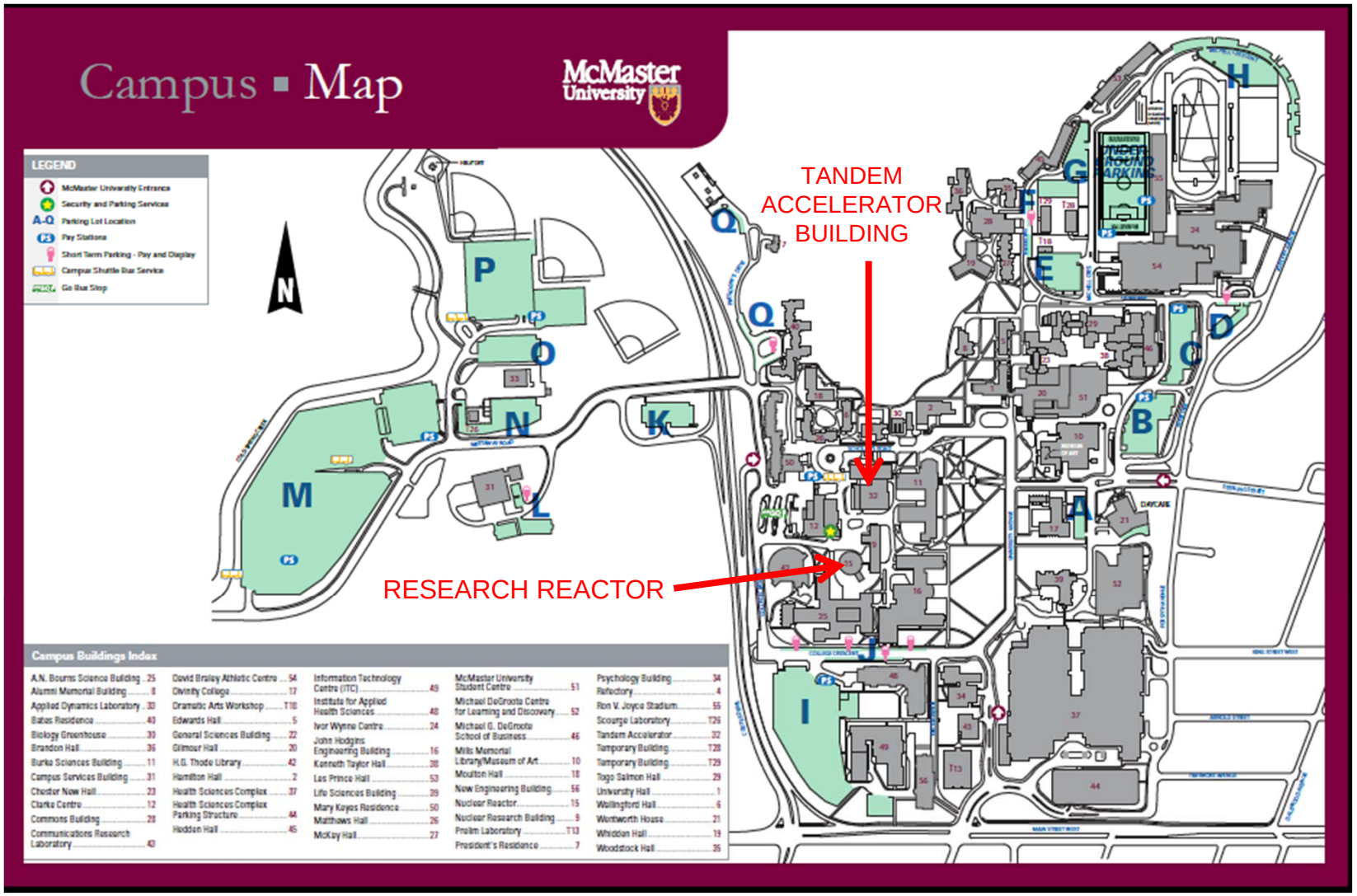
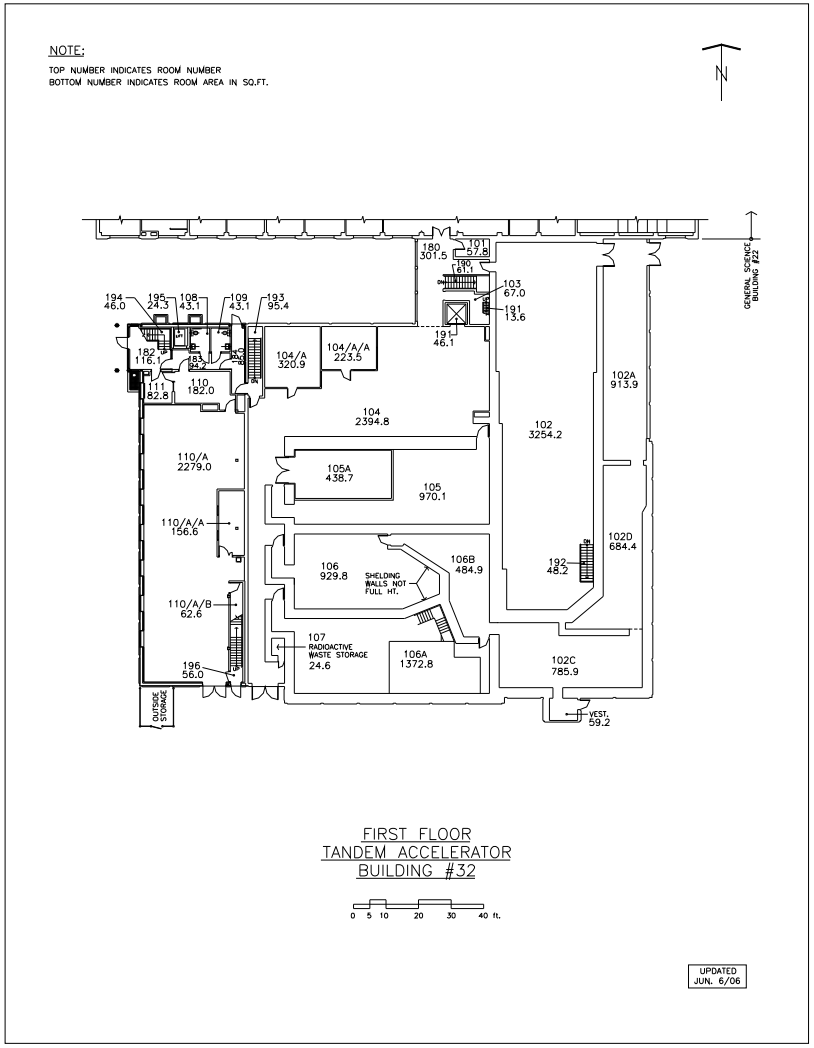
RELATIVE LOCATIONS OF RESEARCH REACTOR & TANDEM ACCELERATOR BUILDING



ROOM 105 TANDEM ACCELERATOR BUILDING

ROOM 105

- EAST-WEST
  - 65 FEET (1981 cm)
- NORTH SOUTH
  - 24 FEET (732 CM)



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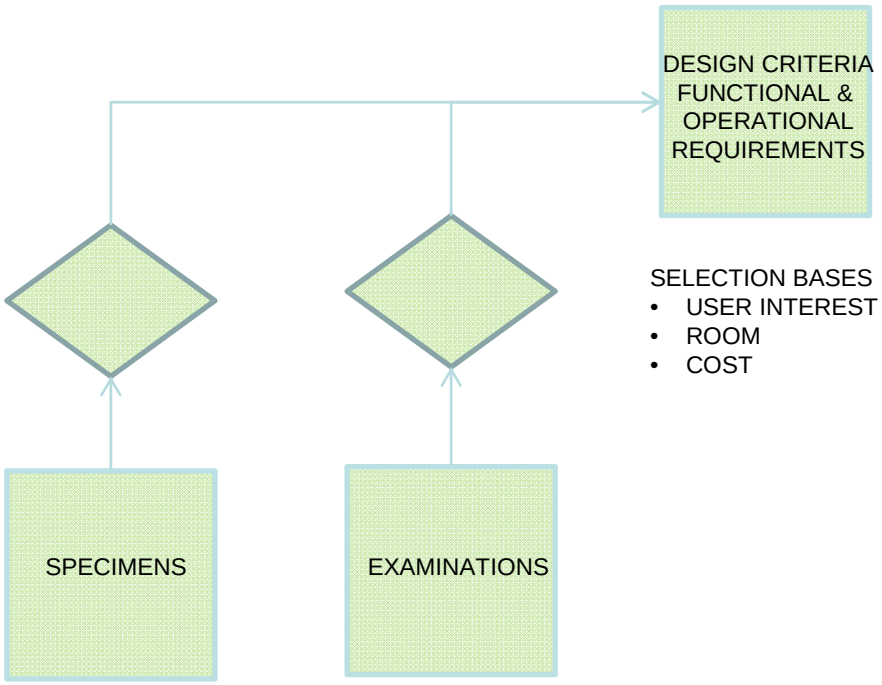
SELECTION OF FACILITY CAPABILITIES
McMASTER UNIVERISTY & MERRICK



- SPECIMEN DESIGN BASIS
  - PRE-SIZED SECTIONS OF CANDU REACTOR PRESSURE TUBES
  - ON-SITE SPECIMEN PREPARATION
  - NO FUEL
- EXAMINATION DESIGN BASIS
  - MACRO MECHANICAL PROPERTIES
    - HARDNESS, BRITTLENESS, TENSILE STRENGTH
  - MICROSCOPY
    - LIGHT
    - SCANNING ELECTRON
    - TRANSMISSION ELECTRON
    - 3-D ATOM PROBE

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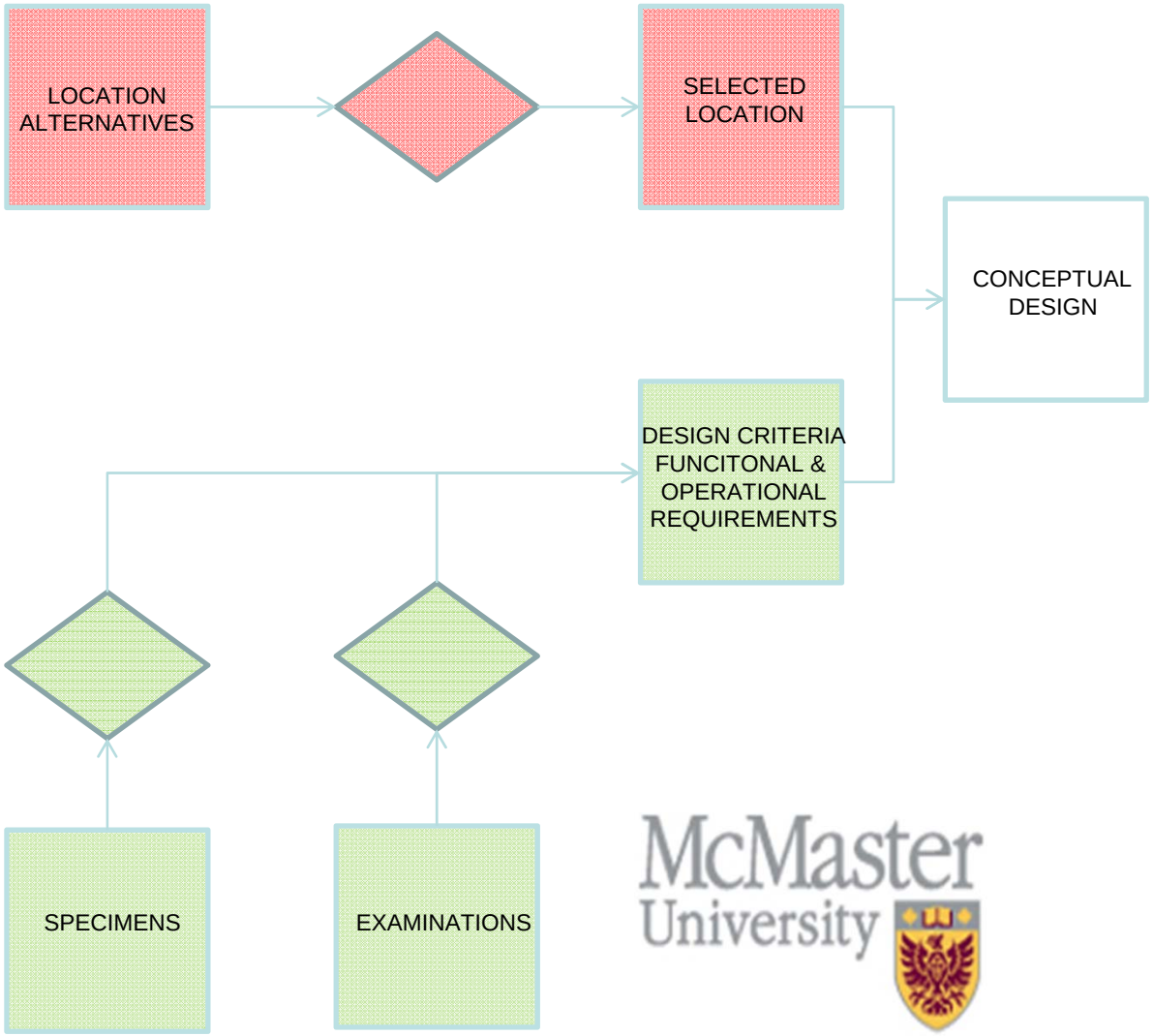
CONCEPTUAL DESIGN



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COST ESTIMATE

COST ESTIMATE IS BASED ON CONCEPTUAL DESIGN

PRINCIPAL FUNDING SOURCES

- CANADA FOUNDATION FOR INNOVATION
- ONTARIO MINISTRY FOR RESEARCH & INNOVATION
- OTHERS
  - GIFTS TO McMASTER (e.g., TEM)
  - IN-KIND CONTRIBUTION OF SERVICES

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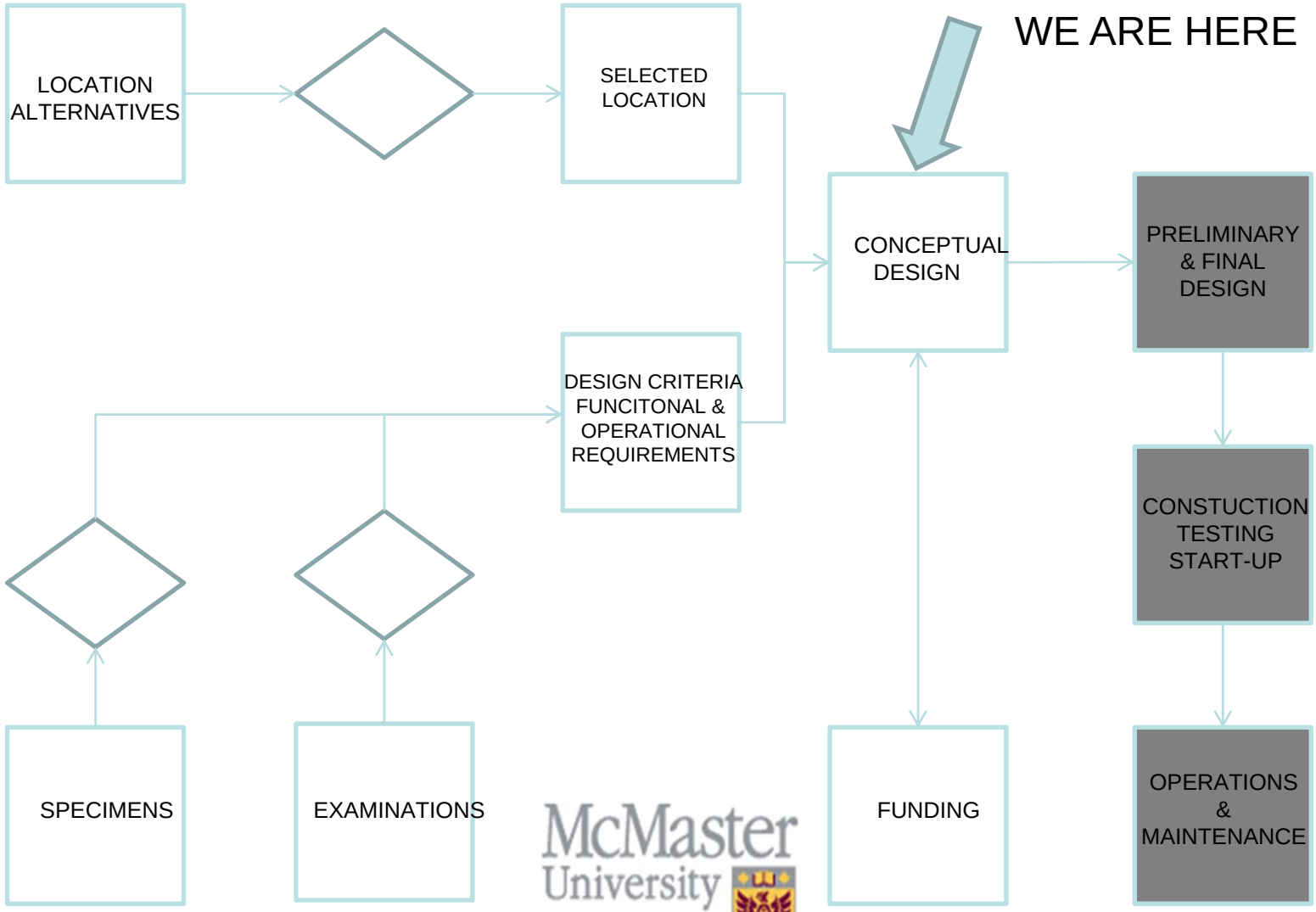
PRESENT PROJECT DEVELOPMENT



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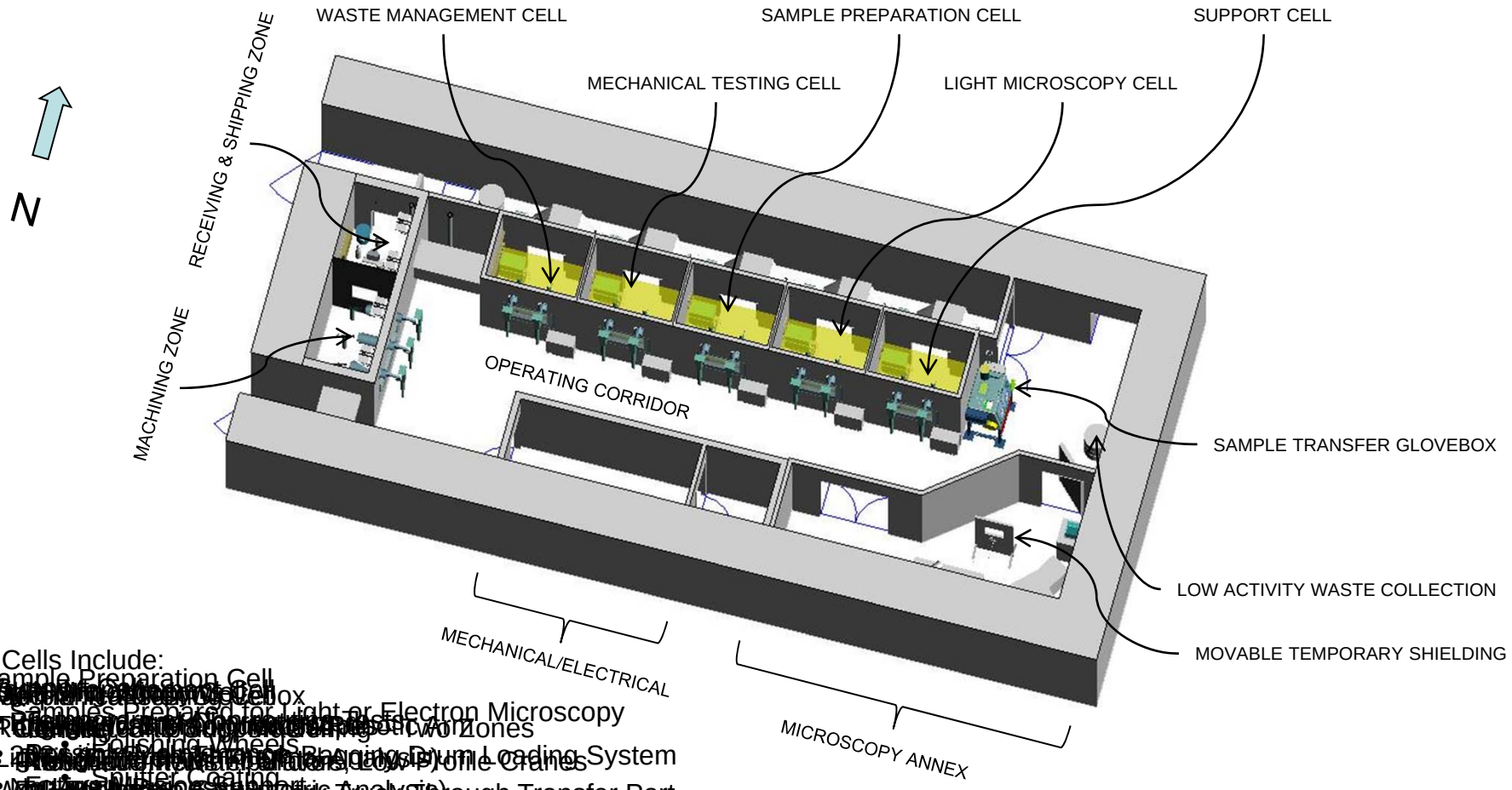
ISOMETRIC VIEW – LOOKING NORTH



All Cells Include:

- Sample Preparation Cell
- Samples Prepared for Light or Electron Microscopy
- Polishing Wheels
- Low Profile Cranes
- Pneumatic Rabbit to SEM or
- Transfer to Light Microscopy
- Moved to Machining Zone Through Partition
- Machining (cut off saw, band saw, 3-way ‘Smitty’)
- HEPA Filtration – Adjustable Cell to Cell Delta P
- Transfer Between Cells

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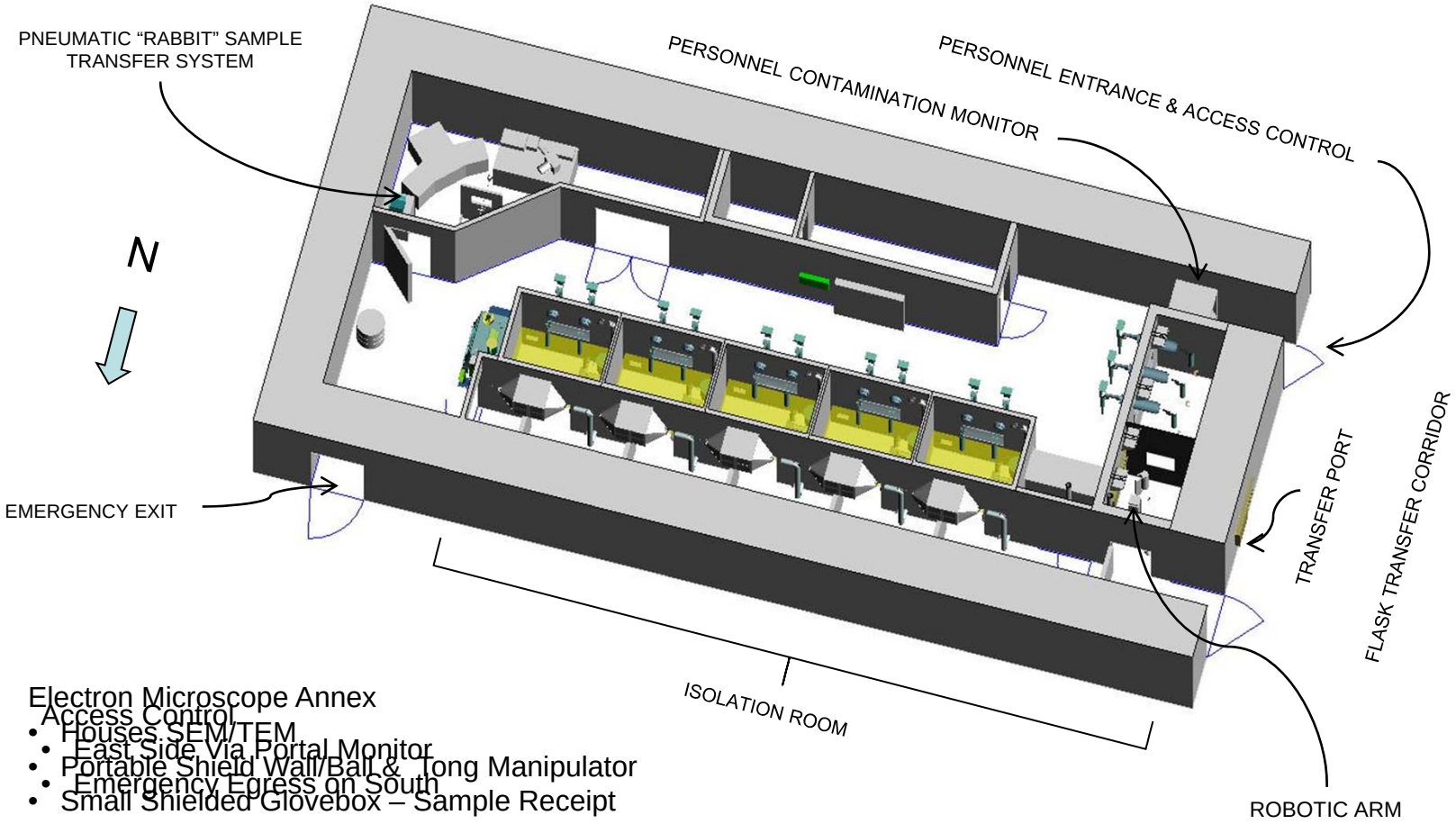
ISOMETRIC VIEW – LOOKING SOUTH



Electron Microscope Annex

- Access Control
- Houses SEM/TEM
- East Side Via Portal Monitor
- Portable Shield Wall/Ball & Tong Manipulator
- Emergency Egress on South
- Small Shielded Glovebox – Sample Receipt
- Sample Storage
- Mechanical/Electrical

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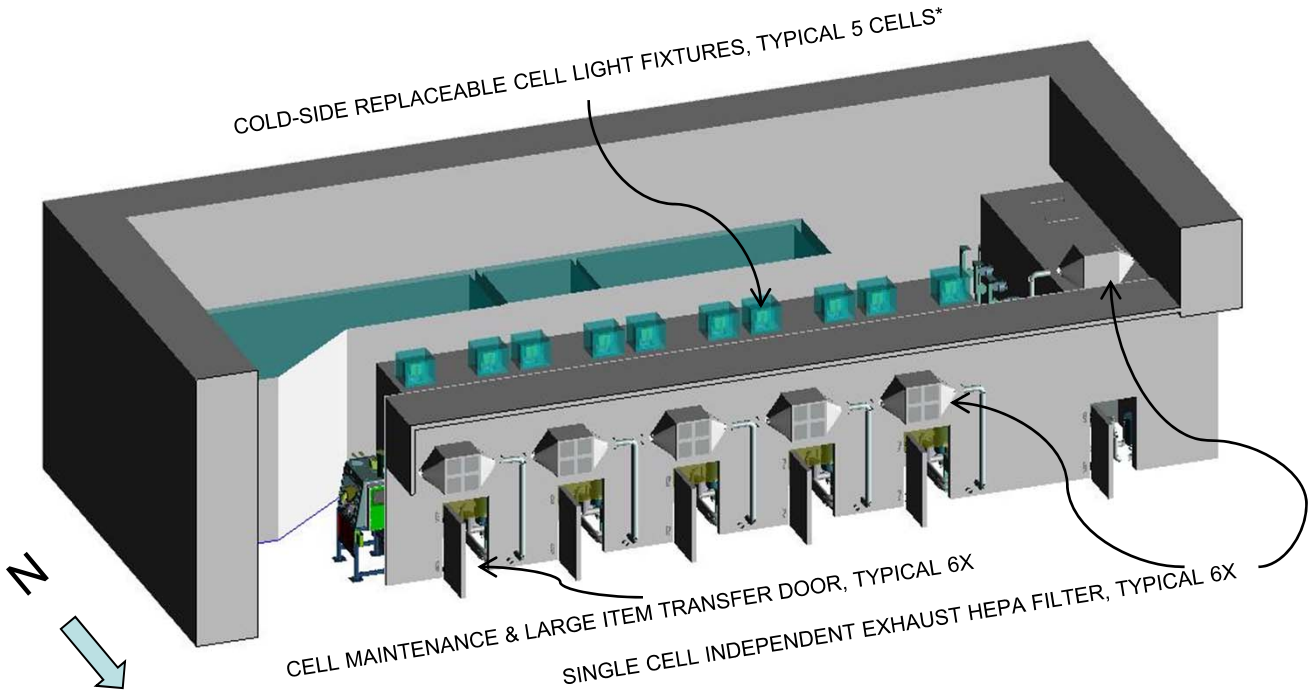
REAR OF CELLS – FROM ISOLATION ROOM



*RECEIPT/SHIPPING/MACHINING CELL LIGHT FIXTURES ARE HOT-SIDE REPLACEMENT

Isolation Zone
Operations/Maintenance Philosophy
- Continuously Spans 'Back' of PIE Cells
- In cell (> 0.1 mSv/hr)
- Potential Shielded Repair Space
- Major Equipment – remote
- Operations and Maintenance
  decontamination and remove

DESIGN CHALLENGES

- LINEAR ARRANGEMENT DESIRED
  - NOT ACHIEVABLE WITHOUT LOSS OF A CELL OR EQUIPMENT TRANSFER
- INSIDE CORNER “DEAD ZONE”
  - NOT VISIBLE THRU WINDOWS OR ACCESSABLE BY MANIPULATORS
  - NECESSARY TO FIT THE CELLS INTO ROOM 105
  - LIMITED AND ROUTINE OPERATIONS – USE OF CAMERAS AND ROBOTIC ARM
- DEDICATED HOT REPAIR AREA NOT ACHIEVABLE
  - IN CELL DECON AND TEMPORARY ENCLOSURES IN ISOLATION ROOM
  - EXTRA MANIPULATOR SPARES
  - OFFSITE REPAIR AND SERVICE AVAILABLE
- REQUIRE FUNCTIONALITY ACHIEVED

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END OBJECTIVE MET

- A STATE OF THE ART FACILITY WITH CAPABILITY FOR:
  - IRRADIATED REACTOR COMPONENT PIE
  - ATOMISTIC LEVEL MATERIALS CHARACTERIZATION RESEARCH
    - 3-ATOM PROBE
    - SEM/FIB (IRRADIATED AND UNIRRADIATED)
    - TEM (IRRADIATED AND UNIRRADIATED)
  - ADVANCED REACTOR MATERIALS DEVELOPMENT

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THANK YOU FOR YOUR TIME!