II-5 Basis of Design: Laboratory

General:

Basis of Design narratives have been provided to define criteria for the project. Use of manufacturer names, products, basis of design examples, or any specific proprietary terms are utilized to establish levels of quality and performance, not indications of sole or source limitations, or preferences for specific manufacturers unless specifically indicated as such. Alternates of equivalent quality and performance may be proposed. Basis of Design criteria have been developed in coordination with Using Agency requirements. However, they do not relieve the design-build team from performing due diligence in the selection of all components, systems, products, assemblies, equipment, etc. for the project.

4.0 Design goals of the facility include the following:

Flexible and Adaptable – Design to accommodate future changes in technology, scientific equipment, and methodology, as well as adapt to the changing demands of testing.

Inviting Work Environment – Provide a professional, healthy, and pleasant work environment for the occupants, while making use of natural day lighting, and exterior views.

Collaboration – Encourage user interaction and professional development using both formal and informal spaces.

Security – Design and construct a secure facility that clearly defines public areas and secure zones, inside and outside of the building.

4.1 General Laboratory Environments:

The interior environment conditions for the labs/ shops shall be characterized by natural light and ambient indirect, diffused lighting provided direct/indirect pendant ceiling-hung lights, augmented with task/exam lights where needed. Some labs may require dimmable-to-off light controls and alternative light sources, among other activities.

Refer to the Room Data Sheets and Mechanical Narrative for additional information.

4.2 Laboratory Casework:

All casework and finishes shall be coordinated and approved between Illinois DOT, and design team and shall be designed to support the general design while providing the full safety and compliance with the Scientific Equipment Furniture Association

(SEFA). See section of report titled, "Laboratory Specific Criteria" under "I–4 Applicable Design Codes and Standards" for more information.

Fixed Casework:
Heavy duty and durable casework are required for all labs. Casework profile to be flush overlay with square edges Refer to Room Data Sheet for locations and additional information

- Base Cabinets:
  - Base cabinets shall consist of a mixture of sitting and standing height base cabinets, with a combination of door and drawer styles.
  - Ratio of doors and drawers is expected to be about 50/50 each but shall be further developed during design phase.
- Upper Cabinets:
  - Upper cabinets shall be of matching materiality and color, in relation to the base cabinets.
  - Upper cabinets to have glass inserts. Glass can be clear or frosted, to be determined.
  - Task light can be provided under upper cabinets.
- Upper Adjustable Shelving:
  - Upper adjustable shelving shall consist of painted metal shelving, to match materiality and color of the base cabinets.
- Lab sinks shall match work surface finish (see below under "Work Surfaces"). All sinks to have removable overflows. Sediment traps may be required at specific sinks, to be determined.
  - Scullery Sinks shall be custom units based on department needs. Refer to Room Data Sheet for additional information.

Casework Hardware:

- Lab-grade hinges
- Casework Hardware capacity shall be determined at a later date considering the weight of materials and equipment to be stored:
  - Chemistry and Transportation Labs :Full extension zinc plated slides with 100lbs capacity, and soft closers
  - All other Labs :Full extension slides with 600 lb. load capacity, full-extension design, and lengths up to 60" and widths of 42" For the heavy loads.
- Pulls to be selected at a later date

Tall Cabinets:

Disposable and non-disposable supplies can be stored in casework drawers, cabinets, and shelves, while solid and liquid waste shall be stored in room-specific locations. Rooms shall be zoned so that material deliveries and waste removal occur at the entrances, so operations are not disrupted.

Wall Protection:

- Bumper Guards: Aluminum, bracket-mounted, Life Science Products, Inc. "Sani-Rail," on all walls without casework at labs
- Corner Guards: Stainless steel, 6" AFF to ceiling height, all outward facing corners in all labs.

Manipulated/Adjusted Cabinetry (as needed):

All Manipulated/Adjusted Cabinetry criteria shall match fixed casework requirements.

- Manipulated/Adjusted casework:
  - Manipulated/Adjusted Cabinetry shall consist of 50% door and drawer units. Match general casework materiality and finish.
  - Manipulated/Adjusted Cabinetry tops to match finish of fixed casework work surfaces.

Tables:

- Fixed tables:
  - Tables shall consist of heavy-duty, height adjustable, painted metal frames.
  - See section on work surfaces for types
- Manipulated/Adjusted tables:
  - Tables shall consist of heavy-duty, height adjustable, painted metal frames, with lockable casters.
  - See section on work surfaces for types.

Work surfaces:

Countertops shall meet general SEFA 3 guidelines. Provisions in pricing should include up to 33% countertops for epoxy, 33% wood butcher block and 33% stainless steel.

- Epoxy or Dekton
- Wood butcher block
- Stainless steel

Utilities (General):

All utilities except for drains shall be delivered to the benchtops and instrumentations via overhead systems. Alternates for running utilities under slab or through trenches may be explored at the beginning of the next phase if IDOT would like to explore. Expected utilities will range from exhaust devices, gases, water, and/ or electrical and data ports.

- **Exhaust Devices:** There are 3 types of exhaust devices.
  - Exhaust devices that collect fumes
  - Exhaust devices that collect dust or particles
    - Wood
    - Metal
    - Silica
    - Plastics
  - Exhaust devices that are directly connected to equipment

- **Gases:** Refer to the Room Data Sheets and the Equipment Matrix for locations and types.
- **Water:** Refer to the Room Data Sheets for type locations.
    - Lab Water: Provide hot and cold lab water at each location, unless noted otherwise.

- **De- ionized water:**
    - Reverse Osmosis (RO): A central system that produces Type III water is preferred. Any labs requiring type II water shall have an owner furnished point of use water purification system with dispenser within the lab.
    - Spaces that require Type II and Type I Provide, 120V GFI electrical outlet, data outlet a cw water with access to a drain.
    - Spaces requiring Type III shall have a DI faucet at each sink.

Table Water Type:

Department	**Feed source from central system**	**Polished Water type**
Analytical Chemistry	Type III	Type I
Bituminous Chemistry	Type III	Type I
Instrument Lab	Type III	Not Required
Cement Lab	Type III	Type I
Aggregate Lab	Not required to be piped to lab since a small volume will be used for calibrations	Not Required
Concrete Lab	Type III	Type II
HMA Lab	N/A	N/A
Soils	Type III	Type I

- **Electrical and data ports:**
  Along perimeter walls, electrical raceways shall be provided in all rooms, unless noted otherwise. Above fixed island benches, power reels shall be provided, unless noted otherwise. Refer to MEP Narratives and the Room Data Sheets.

Various systems for providing utilities will be explored during the design phase:

- **Overhead Service Carriers:**
  Carriers are very sturdy and can carry heavy loads including pumps and instruments over tables. Carriers can be fitted out with shelving and a full complement of utilities including task exhaust devices. However, carriers are bulky and expensive.

- **Overhead utility panels:**
  These panels are lighter and can fit within the structure of a typical ceiling grid. They offer more flexibility; however, they are generally located at the ceiling height and difficult to reach. So selecting the right casework should allow so that those utilities are accessible at the work surface.

- **Umbilicals:**
  The purpose of umbilical's is to bring utilities to the bench when other methods of bringing utilities such as walls, fume hoods, and overhead service carriers are not practical. Umbilicals are not encouraged, but where necessary, they shall be 30"x6" painted metal to match casework with a 4" curb to match worksurface, and a ceiling collar. Alternately, material finish may be upgraded to resin panels.

- Machine shop and other spaces may require utilities to be brought in from underneath the floor, either via open access trenches or through conduit buried within the concrete due to potential conflicts with crane accessibility. If trenching is considered, care must be taken to protect utilities from wet environments such as using NEMA-X rated enclosures.

Room Finishes:

All finishes shall be easily wipeable and cleanable.

- Floors:
  - General Lab areas: Sealed Concrete
  - ESD flooring is required in areas with sensitive equipment, such as the Nuclear and Traffic Instrumentation departments.
- Walls – Wall paint shall be water-based latex, washable, low-luster, unless noted otherwise.
- Ceilings – 2x2 medium textured acoustical ceiling tile. Refer to Architectural Narrative.
  - Ceilings shall be 12' min. unless noted otherwise.
- See Room Data Sheets for addition information.

Partitions:

Standard wall partitions in laboratories shall be CMU block and extend to structure, unless otherwise noted. Refer to Architectural Narrative and Room Data Sheets for all laboratory wall partitions recommendations for each room and space.

- Nuclear department:
  - Hot Room: Walls shall be 16 inches wide and filled with sand or concrete.
  - Calibration Room: Walls shall be 12 inches wide and filled with sand or concrete. Lead lining on the interior face of the walls (to absorb gamma rays rather than reflect them back to gauges).
- District 6:
  - Nuclear Storage: Walls shall be 16 inches wide and filled with sand or concrete.

4.3 Environmental Rooms:

Finishes:

All finishes shall be easily wipeable and cleanable.

- Floor:
  - Moisture Room floors shall be sloped concrete to trench drain.
  - Salt Scale Room floors shall be sloped concrete to trench drain.
- Wall - Prefabricated 4" thick metal clad insulated panels with baked-on white polyester finish on galvanized steel. Exposed exterior and door to be stainless steel.
- Ceiling - Prefabricated 4" thick metal clad insulated panels with baked-on white polyester finish on galvanized steel.

System:

Environmental Control Rooms are expected to be pre-fabricated units, with either air or water cooled systems, and with temperature and humidity controls. Mist system will be integrated into Moisture Room. See Room Data Sheet for more information.

4.4 Fume Hoods:

Fume hoods shall be high-efficiency bench-top and/ or floor mounted with automatic sash closers, and combination sashes to create maximum safety as well as efficiency. All fume hoods shall have emergency power. See Room Data Sheets for more information.

All fume hood utilities currently assume, cold water, a cup sink at each end, and a raceway with 120V duplex in the inside of fume hood. Unless otherwise noted, 208 outlets are not required. See Room Data Sheets for more information.

Each bench-top mounted fume hood shall also include ventilated specialty purpose cabinets below such as flammable, corrosive and/ or hazardous, and possibly vacuum pump cabinets. Cabinets are to be the same color and finish as the fume hoods.

4.5 Freeze Thaw:

General

This requirement documents describes the freeze-thaw machines for the Illinois Department of Transportation, Bureau of Materials, materials testing laboratory. Scope is to include three (3) identical integrated machines and all necessary components to operate such. To maintain brevity in the text, this will be referred to as the freeze-thaw system. Flexibility shall be integrated in the design so that each of the 3 chambers can operate independently, simultaneously at full capacity, or be isolated in operation, as required.

Freeze-Thaw System Overview:

The system shall be capable of producing temperatures in the range of -40 to +80 F required for the freezing and thawing of one hundred and eight (108) concrete specimens per chamber. Each chamber shall hold and test one hundred and eight (108) concrete specimens at a time. The Freeze Thaw System is used to conduct tests in accordance with ASTM C 666-Procedure B; Illinois Modified AASHTO T 161-Procedure B; and Illinois Evaluation of Aggregates for D-cracking Potential.

The freeze-thaw system components and operation verification shall include, but not be limited to:

1. Freeze-Thaw Chamber (3 each) with;
    a. cabinet
    b. refrigeration section with outdoor air-cooled condenser
    c. Air circulation
    d. Thawing Water System
2. Tempering tank
3. Storage tank
    a. Construction
    b. Level Monitoring
4. Control and Automation System
    a. Programmable Automation Control
    b. Set Point Controller
    c. SCR Controller
    d. Multipoint Data Recorder
    e. 10-inch Circular Chart Recorder
    f. Control Panel
    g. Freeze-Thaw Cycle Control
5. Commissioning
6. Ancillary Equipment and Room Criteria

Description
The component parts of the freeze-thaw system shall be interconnected with insulated water piping, insulated refrigeration piping, drain water piping, make-up water piping, pneumatic air piping, electrical power wiring, electrical control interlock wiring, and instrument lead wiring. Specialties such as motorized valves, check valves, balancing devices, refrigerant driers, sight glasses, etc. shall be included as required for the proper operation of the freeze-thaw system. All interconnecting piping shall be type L copper, plastic piping will only be allowed in drain water lines to disposal if compliant with plumbing codes. There shall be no proprietary parts used in the building of the freeze-thaw system.

The contractor shall provide the following services in the same room and within 10 feet of the freeze-thaw system:
1. 100-amp, 208 Volt, 3-phase fused-disconnect switches, dedicated for each chamber
2. 120 psi pneumatic air source
3. Make-up city water supply
4. Sump drain
5. An overhead, powered, 1-ton rated hoist able to traverse the entire length and width of the freeze-thaw room. The hoist height and traverse shall allow users to lift the freeze-thaw racks out of and into each chamber, tempering tank or floor space.

1. Freeze-Thaw Chamber:
Each of the 3 machines shall have the exact capacity of 108 beams. Each machine shall incorporate a heating system, cooling system, and air and water circulation system. Each chamber shall include an insulated lid with an air-actuated/air-assisted opening system.

a. Cabinet:

i. Exterior: The cabinet shall be constructed of 18-gauge steel. All seams, joints, and corners shall be welded, ground, and polished before cabinet is primed and finished with two (2) coats of blue enamel as selected by IDOT. The lid shall be top opening to 90 degrees from the closed position and provide full access to the interior working space. Access panel(s) should be available such that any maintenance or repairs can be conducted from the front of the machine.

ii. Lid: The lid of each chamber shall be operated by two (2) heavy duty pneumatic air cylinders controlled by a manual 3-position hand valve. The valve's positions shall be lettered up, hold, and down. The air cylinders shall be capable of opening the lid through a full 90-degree arc so that the chamber can be fully accessed for specimen loading and unloading. The air cylinders shall be operated from a 120-psi pneumatic air source supplied by the buyer. The system shall include a flow control device to balance the speed of the air cylinders as indicated by the operating personnel. The system shall include a pneumatic air filter, pressure regulator, and lubricator. The lid shall be gasketed with neoprene material (1/2" x 2") to provide an airtight seal of the interior chamber when in the closed position.

iii. Interior: The interior wall of the chamber shall be 10-gauge #304 stainless steel. The bottom of the chamber shall be ¼" #304 stainless steel plate and shall be capable of supporting a uniform loading of 150lb/sf. The bottom shall drain chamber water to its center where a bottom drain connection will remove the water. The sides and bottom pieces shall be joined together by welding be watertight. The interior chamber shall be insulated from the exterior cabinet housing with two (2) layers of 2" urethane foam and two (2) layers of 1" fiberglass board on all sides and the lid. Each layer shall be applied with mastic, staggering the joints, to seal the mating surfaces and joints. There shall be a minimum of two (2) 1" ports installed in the vertical wall of the chamber above any possible water level to permit passage of the thermocouple lead wires from the chamber's interior to the control and recording panel.

iv. Specimen supports for concrete beams: Supports shall be provided inside the chamber for the concrete specimen racks and be capable of supporting a uniform loading of 150 lb/sf. The support shall be constructed to allow a minimum of 5" clearance above the bottom of the chamber to allow free flow of refrigerated air and thawing water to all surfaces of the specimens. The top surface of the base support shall be located approximately 18" below the surface of the thawing water when it is at normal operating level. A total of twelve (12) welded sectional stainless-steel racks (holds 18 specimens per rack) shall be provided for keeping the specimens in an upright position, with sufficient net free space around them to allow circulation for the heat exchange medium to produce the temperature conditions specified. Each welded section shall be provided with two (2) hooks and spaced to allow use of the existing hoist to permit the removal of loading of the eighteen (18) specimens at one time. The racks shall be designed such that the pins in the ends of the specimens will not contact the racks or supports. IDOT will provide examples for the contractor to measure as examples.

v. Drains: A 2" safety overflow drain connection shall be installed in the rear of each chamber cabinet to provide run off in the event of accidental excessive water level in the chamber; this shall be piped to the room sump. The drain in the bottom of the chamber shall be 2" and be provided with a strainer plate. Thawing water will be removed via the bottom drain by pump. The drain shall have easy access for cleaning.

b. Refrigeration Section (with outdoor air-cooled condenser):
The refrigeration section housing the mechanical and electrical systems shall be constructed from the same material as the chamber cabinet and finished to match its color. The compressor shall be a two-stage semi-hermetic type motor compressor built for low temperature operation using refrigerant R-507. The compressor shall have a remote air-cooled condenser equipped with low ambient control. The compressor shall be supplied with operating and safety controls including, but not limited to: motor protection, oil loss

protection, high pressure protection, and refrigerant loss protection. The compressor shall be supplied complete with refrigerant receiver, crank-case heater, suction accumulator, motor control panel, and all additional specialties as required for low temperature operation down to -40 degrees F. The compressor capacity shall be sufficient to freeze the concrete specimens from an average interior temperature of+40 degrees F down to 0 degrees F, within the time frame specified by the ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential. The unit shall be capable of performing eight (8) freeze-thaw cycles per day, while performing ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential. The evaporator cooling coil shall be constructed of dehydrated ¾" OD copper refrigeration tubing, having 4 copper fins per inch, and with a #304 stainless steel casing. The coil shall be 16 rows deep and have two (2) row split circuits. Each circuit shall be complete with a refrigerant distributor and thermal expansion valve having external equalizing features.

c. Evaporator Fan: The evaporator fan shall be a backward inclined, self-cleaning, all stainless-steel centrifugal fan direct driven by an electric motor with a stainless-steel shaft. The fan shall be constructed of #304 stainless steel and bolted to the housing for access to the wheel. The air discharge opening shall be fitted with a stainless-steel diffuser complete with adjustable air deflecting vanes for balancing and directing the air flow inside the chamber.

d. Thawing Water System: The thawing water shall be exchanged between the storage tank and the freeze-thaw machine as required for the current freeze-thaw cycle operation. Before the freeze cycle starts, the water shall be pumped from each chamber to the storage tank. This shall be the chamber's drain cycle and be completed within a time frame of 5 minutes. The water shall be contained in the storage tank until the start of the next cycle when it is pumped from the tank to the chamber in 5 minutes. The fill and drain cycles of each chamber shall be monitored and controlled by solid state low- and high-level capacitance level sensors having probes mounted in the wall of each chamber. Mechanical float assemblies for controlling water levels will not be accepted. The water level sensing devices that control the level of water in each chamber and help sequence the filling and draining of each chamber and subsequent fan and pump operation shall measure capacitance on the probe to determine water level. The level of water on the probe shall be electronically set and fully adjustable as well as the differential between on/off and time delays be adjustable.

i. Agitation: Each freeze-thaw chamber shall be supplied with a circulation pump that shall be an iron body bronze fitted pump, 4 in suction x 3 in discharge with a BHP rating of 3HP, and be 3 ph. Agitation of the thawing water shall be by forced circulation inside each chamber to create turbulent flow of the water over the complete surface area of every specimen being tested. The agitation process shall thaw the concrete specimens from an average interior temperature of 0 degrees F to +40 degrees F within the time frame

specified by the ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential.

ii. Heating System: The thawing water shall be heated as required to thaw the concrete specimens at the correct rate and time frame specified by ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential. This shall be done by an electric circulation heater installed in the water agitation system. The heater shall be controlled by an SCR controller that will provide time-proportioning power input to the electric element. The heater control circuit shall be interlocked with the refrigeration cycle so that there will be no simultaneous operation of the two.

iii. Fill and Drain Pumps: Fill pumps and drain pumps shall be iron body bronze fitted pumps and be 2" in-line with a BHP rating of 2HP, and be 3 ph. Fill and drain pumps shall be located integral to the refrigeration section and be controlled by automation and manually.

2. Tempering Tank:

The tempering tank shall be capable of holding six (6) racks of freeze-thaw beams. The tempering tank shall be made of 18-gauge steel. All seams, joints, and corners shall be welded, ground, and polished before cabinet is primed and finished with two (2) coats of blue enamel identified by IDOT. The external tank heater shall work with the outside water storage tank to maintain a water temperature of 72 degrees F +/- 1 degree F. The tank shall include a sump pump or other means to prevent the tank from over filling and a means for water to drain to account for the displaced water as specimens and racks are added to the chamber. A digital display shall be provided to indicate the water temperature of the tank by use of a single thermocouple beam. The control panel for the tempering tank shall be 208V, 3 pH SCR with option for manually adjusting the tank operation. The tempering tank control panel shall include a Manual, Off, and Auto switch and related pilot lights for manual operation of: "Master", "Pump" and "Heat". The tempering tank control panel shall also include indicator lights for the "heater contact closed" and "pump contactor closed". The tempering tank shall include a water circulation pump to continuously circulate the temperature-controlled water. The pump shall be ¼ HP, single phase, and 1725 rpm. Supports shall be provided for the concrete specimens in the tempering tank and be capable of supporting a uniform loading of 150 lb/sf. The support shall be constructed to allow a minimum of 5" clearance above the bottom of the chamber to allow free flow of tempered water to all surfaces of the specimens. Manual opening of the lid through a full 90-degree arc so that the chamber can be fully accessed for specimen loading, unloading, and cleaning shall be required. When placed in an open orientation, the lid shall remain open without propping. A means to completely drain the tank shall be provided for cleaning.

3. Outside Storage Tank:
A water storage tank will be required to store water for the freeze-thaw system. The tank will be placed exterior to the building. The tank shall be sized to simultaneously hold the full amount of water from each freeze-thaw chamber.

A. Construction: The storage tank shall be a vertical flat-bottom fiberglass container. The tank shall be covered with a 2" layer of polyurethane foam insulation having a minimum U factor of 0.086 BTU/hr/sq ft/deg F. The insulation shall be coated with a protective coat of resin and chopped fiberglass strand with a pigmented white gel coat. The tank shall be trimmed with a 2" upper fill connection and a 2" lower drain connection. Fill and drain of thawing water from the freeze-thaw chamber shall be via mechanical pumps. The tank shall have a side-mounted flanged manway for use in cleaning and inspection. It shall be held in place with stainless-steel bolts and be sealed with a neoprene gasket. The tank shall be fitted with a top-mounted air vent, an electric tank heater/colling system to maintain 40+/-5 degrees F.

B. Level Monitoring. The tank water level shall be maintained and controlled by an automatic water feed system including a solenoid fill valve, "Y" strainer, shut-off valve, and manual fast-fill valve. A means for the water fill mechanism to automatically shut off once the tank level is full shall be supplied and installed. Remote monitoring of the storage tank water level shall be supplied inside the lab. Measurements shall be included to know what level the water in the tank is in relation to how many chamber(s) are full/empty of water.

5. Control and Automation System:
The control panel shall house the freeze-thaw control system including programmable automation controller (PAC), setpoint temperature controller, SCR heat controller, chart recorder, multipoint data recorder, motor starters, control relays, terminal blocks, component fuses and other components. The control panel shall be housed inside a free standing NEMA 12 enclosure, primed, and finished with two (2) coats of Blue enamel selected by IDOT. The enclosure shall include a front door window so that the read out displays of the control panel can be viewed while the door is closed. The control panel shall be mounted as a swing-out panel so that all the components can be serviced without removal. The control panel enclosure shall be set adjacent to the freeze-thaw chambers and wired to the various motors, heaters, controls, and sensors mounted on the chambers. Each freeze-thaw machine/chamber and the tempering tank will be monitored individually at the control panel.

A. Programmable Automation Controller (PAC): The freeze-thaw controller shall be a microprocessor-based primary controller capable of programming at least seven (7) events, sixty (60) straight line segments that provide ramp and soak functions, and output analog setpoint commands.

B. Setpoint Controller: The setpoint controller shall be microprocessor-based and contain a nonvolatile memory. It shall include a digital output for control of the refrigeration cycle and an analog (4 to 20 MADC) for control of the heating cycle. The controller shall receive a temperature signal from the thermocouple sensor (type T) that is cast into a specimen in the chamber.

C. SCR Controller: The SCR controller shall receive an analog signal (4 to 20 MADC) from the setpoint controller whenever heating of the thaw water is required. The SCR controller shall send a modulating power voltage to the circulation heater in an amount sufficient to heat the water for thawing the specimens.

D. Multipoint Data Recorder: The data logger shall record temperature inputs from thermocouple sensors (type T). The data recorder shall include a clock for time of day recording of the temperature values. The data recorder shall record the temperature values of the master specimen, various other specimens, and chamber interior (by use of a fixed probe). The data recorder shall record the number of cycles on a continuous basis. The display shall be at a minimum a 5.5” 1.4 VGA display with 16-bit color, touch screen control, and graphic based menu driven programming. It shall have eight user defined programmable display screens and ten programmable display formats. Data storage shall be at a minimum 32 Megabyte of internal RAM. Data communication will be via an ethernet connection identified by IDOT.

E. 10-inch Circular Chart Recorder: The chart recorder shall record the temperature of the master concrete specimen while the freeze-thaw test is in progress. The input signal shall be from a thermocouple (type T) cast into the specimen. The chart recorder shall have a digital display that indicates current sensor input value. This recorder is to be microprocessor based with programmable chart speeds. The chart recorder shall utilize the same paper charts as the existing freeze-thaw system chart recorder.

F. Control Panel: The control panel shall include a start cycle push button switch, a control panel power switch, and an instrument power switch. The seller shall also supply the Department with the software necessary for programming and data collection, along with a back-up file and ten (10) licenses for the software. The control panel shall include a Manual, Off, and Auto switch and related pilot lights (at a minimum) for manual operation of:

1. Power on
2. System offline
3. System online
4. Cooling fan
5. Condenser fan
6. Cooling cycle
7. Agitation pump
8. Water fill pump
9. Water drain pump
10. Gravity drain valve
11. Thawing cycle

G. Freeze-thaw Control Cycle: The equipment shall meet the requirement of ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential. The testing method shall be Procedure B-Rapid freezing in air and thawing in water, with the exceptions noted below:

ASTM C 666-Procedure B; AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential-the normal freezing and thawing cycle shall consist of, alternately lowering the temperature of specimens from +40 degrees F to 0 degrees F and raising it from 0 degrees F to +40 degrees F in not less than 2 nor more than 4 hours. Not less than 20% of the time shall be used for thawing. At the end of the cooling period, the temperature at the center of the specimens shall be 0 degrees F +/- 3 degrees F and at the end of the heating period, the temperature shall be +40 degrees F +/-3 degrees F with no specimen at any time reaching a temperature lower than -3 degrees F nor higher than +43 degrees F. The time required for the temperature at the center of any single specimen to be reduced from +37 degree F to +3 degree F shall be not less than one half of the length of the cooling period, and the time required for the temperature at the center of any single specimen to be raised from +3 degrees F to +37 degrees F shall be not less than on half of the length of the heating period. The unit shall be capable of performing eight (8) freeze-thaw cycles per day, while performing ASTM C 666-Procedure B, AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential testing.

H. Freeze/Thaw System Integration

The system shall incorporate automated controls and data acquisition to allow the simultaneous operation of all three testing chambers in the same or different portions of the freezing, thawing or transition. All supporting pumps, tanks, piping and drains shall be sized to allow for simultaneous operations.

The system shall be remotely monitored via a desktop, networked IDOT computer. Software must be compatible with State of Illinois and IDOT standards and policies.
The system shall provide an overall status of all data and control points and a display of the thermocouple data. Data to be labeled and separated by chamber.
The system shall incorporate alarms and notifications for system and component failures; power or actuator loss; or data loss.
The system shall include software, back-up media, and licenses for up to 10 desktops. Complete software documentation is required in hardcopy (3 copies) and electronic format.

5. Commissioning:
Upon completing the installation of the freeze-thaw system, the seller shall start and run all components and completely test them for proper operation in accordance with manufacturer's literature. The Freeze Thaw System shall be tested through the various cooling, heating, drain, and fill cycles including calibration checks and adjustments, to ensure that the specifications of ASTM C 666-Procedure B, Illinois Modified AASHTO T 161-Procedure B, and Illinois DOT Evaluation of Aggregates for D-cracking Potential are met. The seller shall then make trial runs using specimens (dummy specimens) supplied by the Department. During these trial runs, the seller shall instruct the Department's personnel in the complete operation of the freeze-thaw system. The seller shall program the system controllers using input values supplied by the Department. The programming strategy shall be completely tested by actual online operation of the freeze-thaw system until the specified testing parameters are achieved.

The seller shall prepare and deliver to the Department, three (3) hardcopies, and an electronic copy, of the complete operating and maintenance instructions for the freeze-thaw system above and beyond any other documentation requirements.

6. Ancillary Equipment and Room Criteria

A. Bridge Crane System

A steel bridge crane system suspended support by the building structure, or stand-alone built such that it does not reduce room's inside clearances shall be provided to lift of sample racks between a floor-level transport cart, each sample chamber and the tempering tank without obstruction. The hoist system trolley shall have a capacity of 1 ton. The steel bridge crane system shall be OSHA certified through various tests to ensure that it meets the required safety standards. These tests may include load testing, function testing, and visual inspections of the hoist components.

The bridge and runway must allow for access to all freeze machines, tempering tank and floor area for loading/unloading, and transfer between units while free and clear of obstructions.

1. Bridge
2. Runway
3. Trolley: Electric assisted trolley with pendant controls, Hook block with 2 hooks for supporting wire baskets
4. Spreader bar
5. Lifting jig

B. Workstation and Storage

The room will need additional space for cabinets, located close to the machines, this is important for charts, spare parts, pumps, and couplers. A workstation with power and data adjacent to the machines will be required.

C. Ambient Conditions

Recommended conditions are to maintain 10 - 25°C, (50 - 77°F) max. humidity ≤ 60%. Heat output from each freeze/thaw unit is estimated at approximately 60K BTU. General Room Exhaust located above refrigeration portion of tanks for the elimination of odors and concentration of refrigerants, as well as residual heat generated by the equipment.

D. Power

Each of the freeze/thaw system units will be hard wired through their respective controller. The power loads of the units shall be designed to the requirements of the new facility. The existing facility units are each based on 230v/3ph 100amp power requirements.

Convenience outlets providing 120V service for equipment cleaning shall be provided at the end of each aisle and in-between equipment and adjacent to the sump pump. The workstation adjacent to the machines shall receive one quad receptable and data.

E. Emergency Power

The freeze/thaw ~~testing units shall be provided with backup emergency power to prevent loss of testing cycle and data collection.~~ system is critical, the cabinets need to be able to be safely drained, cabinets opened and specimens removed by crane during a power outage. All data must be kept and stored during an outage. Ensure that the crane/hoist system is on emergency power for the safe removal of sample during a power outage.

F. General Floor Drainage

In addition to a sump pump, a floor drain with sediment trap and cleanout is beneficial to the processes around the equipment in the center of the room.

G. Structural Slab

The slab shall accommodate the weight of the equipment, water, and full load of concrete sample specimens. Equipment weight including water and specimens is estimated at approx. 6,000 lbs, and shall be determined during design.

H. Lighting~~:~~

Ambient Light Level 60-80FC, typical lab lighting.

4.6 Photometric Lab:

The photometric lab is used for testing the reflectance of light from paints, finishes and other materials at various angles from a specific distance. The test uses a light source and reflectance sensor at one end of a tunnel and a fixture for mounting the objects at the other. A computer control workstation can be located against a wall out of the test's light path and should be moveable. Tall cabinets for miscellaneous tools should be mobile. The overall room dimensions are governed by the test being performed and are currently 60' long by 8' wide and 10' tall clear.

Refer to Chemistry Lab's Analytical Chemistry Room Data Sheet 2.73.5 for Photometric Lab requirements.

4.7 Safety:

It is recommended that the following safety features be provided in or accessible to each laboratory and meet OSHA and/or ANSI requirements for configuration, operation, and location.

Safety Stations/ Emergency Shower:

Provide safety station with a deluge shower at centralized receiving area, within 75' of all laboratories. Water shall be tempered. Safety stations and emergency shower shall be equipped with flow alarm tied to the central security. Height of eye/face wash basin, deluge shower pull ring and deluge showerhead should meet ADA and ANSI requirements.

Provide safety stations, consisting of an eye/face wash and chemical spill kit in each lab at all the sinks within 10 seconds travel distance of any laboratory per ANSI Z358.1. The specific number and location will be based on the most stringent of the following: building configuration, code or owner's standard.

Eye/Face Wash:

Handheld, eye, face and body wash/drench hose unit should be provided at each designated sink in the laboratory. Deck mounted units shall be mounted 15" from the edge of countertop.

Fire Extinguishers:

Fire extinguishers should be located in each laboratory and their adjacent Receiving Area. The specific number should be driven either by code or by owner's standard, whichever is more stringent.

Signage:

Appropriate signage indicating, but not limited to Radioisotope, Flammable, Caustic, Microwave, Magnetic Field, Biological Hazard or Nuclear, should be posted on each appropriate laboratory entry door. A sign is required by the Illinois Department of

Nuclear Safety for the room with the X-ray. Signage to be furnished by contractor and/ or accommodated in the wall-mounted room name/occupants signage system.

Laboratory Accessibility:

Accessible routes, doorways, and door clearances shall be provided throughout the laboratories. Safety stations will also be ADA accessible.

Laboratory casework, sinks, and fume hoods will not be designed to be accessible at this time, but IDOT shall provide casework modifications in the future as the need arises. All workstations shall be at 36” above finish floor, unless noted otherwise. Eye wash stations provided at casework sinks will be in addition to the accessible safety stations.