Heating the 9th Street Interchange, Louisville, KY

James H. Havens
Kentucky Department of Highways
HEATING THE 9th STREET INTERCHANGE
LOUISVILLE, KENTUCKY

Jas. H. Havens
Research Report
400

HEATING THE 9th STREET INTERCHANGE
LOUISVILLE, KENTUCKY

1 64-2(87)3

KYHPR-71-65; HPR-PL-1(10), Part II

by

Jas. H. Havens
Director of Research

Division of Research
Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

in cooperation with the
Federal Highway Administration
U.S. DEPARTMENT OF TRANSPORTATION

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September 1974
INTRODUCTION

The 9th Street interchange, I 64-2(87)3, was first conceived about 1959. Preliminary design studies began in the early 1960's. Design began about 1964. The idea of heating the ramps was first considered in the early 1960's but was not pursued intently until the final design stage (about 1968). As the design progressed, it became more and more evident that snowing and icing conditions could prevent otherwise normal passage of traffic up and down the ramps. At one point on the structure, a combination of superelevation and grade would produce a 6 1/2 percent slope. The highest ramp or "fly over" would stand about 80 feet in the air and project out over the Ohio River. A single vehicle askew could cause a severe pile-up and back-up of traffic. If cinders and(or) salt could not be brought in, people might abandon their vehicles. A tram system to bring in abrasives and salt was considered as an alternative to an electrical heating system in the deck. Several ideas were explored in an attempt to avoid imbedding wires in the deck slabs. "Heat pipes" were considered; but costs were then very great, and production in sizes and lengths could not be assured. The pro's and con's of imbedding cables in the concrete as compared to imbedding them in a bituminous overlay were weighed; the deciding factors were: (1) the improbability of finding a satisfactory schema for cable replacement in either case, (2) the apparent advantages of providing extra heating capacity together with back-up circuitry. Conduits were rejected because of heat-transfer problems inside the conduit and costs. Of course, the question arose: What will happen to the cables when cracks develop in the concrete? Someone remarked: "There are no cracks on these plans". However, to avoid concentrated deformations and stressing of the cable if cracks occurred, it was decided to lubricate the cable to prevent bonding to the concrete. This would also prevent stress rises due to differential thermal expansion.

Hazelet and Eradal of Louisville were the principal consultants; they engaged Bosch & LaTour of Cincinnati to design the electrical heating system and controls and monitors.

The design criteria or guidelines established by the Department are summarized as follows:

1. Three, independent, parallel, 20-watt circuits with variable, controlled inputs; to provide a total heating capacity of 60 watts per square foot.
2. Imbedded, MI (mineral insulated) cables, interrupted at joints and otherwise sectionalized.
3. Prevent icing and clogging of deck drains and downpipes.

4. Provide building to house controls and monitors.
5. Provide TV monitoring throughout.
6. Provide ice-detecting sensors at strategic points.
7. Provide remote-reading temperature sensors and recorders.
8. Provide meters and telltale indicators of circuit operation.
9. Provide operating and maintenance manuals and operator training.

DESCRIPTION OF SYSTEM

The total heated area is approximately 165,000 sq ft. The low ends of ramps on fill will also be heated, but at 50 watts per square foot rather than 60.

The main power feeder from L.G. & E. will be an underground, 13.8 KV, 3-phase, 3-wire system and will supply 13.2 KV to the main switchgear. There will be a 1200-amp, 500 MVA, air-type, circuit-breaker ahead of L.G. & E.'s meter. A major component of the system is a motorized, 16-step, high-voltage regulator having a range of 2200 to 13,800 volts; this regulator feeds five substation transformers. Each substation feeds two sections of deck heaters. The maximum, secondary voltage at the substations will be 480 volts, phase to phase, and 277 volts to neutral ground. The secondaries are "Y-type"; each circuit will return to the neutral. Secondary taps will be matched to the length of the heating cables. The maximum input to any heater circuit will be 277 volts. Load meters will be provided on the secondary side of each substation. Each substation will supply about 2,500 KVA. Heating 165,000 sq ft at 60 watts per square foot represents a load of 9,900 KW.

Theoretical calculations indicates that the skin temperature of the MI cables may approach 350 F. Cable manufacturers report that the skin temperature of cables imbedded 2 in. in concrete seldom exceed 150 F. Low skin temperatures are important from the standpoint of minimizing corrosion of the sheath. By controlled operation, it may be possible to limit skin temperatures to less than 100 F.

The MI cables for the project will consist of a single, copper (No. 16) conductor with MgO-insulation in a stainless steel sheath. There will be a "cold section" about 6-ft long (No. 6 copper wire) at each end of each cable; these connections will be welded. The cables will be spaced approximately 6 in. apart.

There will be two weather stations mounted on standards above the plinth; and six, pan-and-tilt, zoom TV cameras will also be mounted on standards in weatherproof heated housings, with window wipers, so
that the operator may observe deck conditions and traffic flow on monitors in the control building. There will be twelve, recording, thermocouple channels and recorder-regulator automatic control to a preset deck temperature (20 to 50°F). There will also be overriding manual control, but "full automatic" involves logic circuitry coupling weather station sensors and deck temperature sensors with the power regulator. Safety devices prevent overheating. There will be a provision for possible future control from the District Office. Sound-powered intercom will be provided through plug-in jacks at all significant junction boxes.

There will be altogether more than 240 thermocouple points. At each thermocouple station, there will be six points at various depths near the gutter and six points at the centerline of the deck. The surface point will be the control sensor.

The terms of the agreement with L.G. & E. are as follows:

1. $5,920 (minimum) (14,800 h.p. @ 40¢; or 11,050 KWH, 26.5 hrs full-load heating per month) between October 15 and April 15.
2. Provide standby service from October 1 to October 15 and April 15 to May 1, billing only for energy used.
3. 2.1¢ per KWH exceeding 11,050 KWH per month, less 5 percent.

Installation of heating cables is expected to begin in September and will continue into next summer.

The prime contractor is the E. Randle Company and R. R. Dawson Bridge Company; the cable manufacturer is the Nelson Electric Company; and the electrical subcontractor is Marine Electric Company. Bids were taken April 26, 1973. The lumps sum bid items were as follows:

<table>
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<tr>
<th>Item</th>
<th>Cost</th>
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<tr>
<td>Electrical Distribution System</td>
<td>$750,000</td>
</tr>
<tr>
<td>Roadway Heating and Connectors</td>
<td>720,500</td>
</tr>
<tr>
<td>Control Building</td>
<td>202,000</td>
</tr>
<tr>
<td>Instrumentation System</td>
<td>168,500</td>
</tr>
<tr>
<td>TV System</td>
<td>69,550</td>
</tr>
<tr>
<td>Total</td>
<td>$1,900,550</td>
</tr>
</tbody>
</table>

The total for the project was 13.27 million dollars.

PLAN DETAILS

Several plan details are shown on a few sheets included herewith as an appendix. Site photos precede the appendix.

RESEARCH ASPECTS

In the beginning, the research project included operation for a 5-year term. This was before the decision was made to heat the entire area of the interchange ramps. The decision to provide three parallel, 20-vatt circuits throughout greatly magnified the power-distribution system. Sectionalization created the need for substations and automation. In effect, the system exceeded the limits of "eyeball" and manual control. The TV surveillance system became an operational necessity. The intercom system became a construction necessity and was built in for possible, future circuit checks. Ice detectors and a few thermocouples were planned originally; and, of course, there would have to be power meters or watt-hour meters if only for billing purposes. Rather than having an operator going from station to station punching control switches to activate portions of the system, central control and surveillance seemed more and more compelling. Housing for switchgear, controls and instrumentation, and operating personnel became necessary.

Basically, there are three research aspects to the project, as follows:

1. Evaluations of equipment and wiring performance in the system; these will include records of maintenance required and failures of wiring and heating circuits, if any.
2. Evaluations of total operating costs; power costs in various modes of operation (with or without preheating when there is advance warning and lead time); energy demand with respect to snowfall, wind, and air temperature; and surface temperatures needed.
3. Evaluations of costs and benefits on an accrual basis.
HEATINGS

+ DRAWINGS

<table>
<thead>
<tr>
<th>SHEET NO.</th>
<th>TITLE</th>
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<td>0 45</td>
<td>HEATING CABLES RAMP 1 &amp; RAMP 3 APPROACH</td>
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<td>HEATING CABLES UNIT PLANS R2 - III</td>
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<td>0 85</td>
<td>HEATING CABLES UNIT PLANS R40 - XXX</td>
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### LIST OF MATERIALS FOR RAMP HEATING

#### ROADWAY HEATING SYSTEM AND INTERCONNECTIONS (LUMP SUM)

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<th>Reference</th>
<th>Estimated Quantity</th>
<th>Estimated Quantity</th>
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<td>Heating Cable Assembly for Bridge Ramps</td>
<td>D14-04A, D14-04B, D14-04C</td>
<td>1,336 Ex.</td>
<td>2,000 L.F.</td>
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<td>Heating Cable Assembly for On-Grade Ramps</td>
<td>D14-04E, D14-04F, D14-04H</td>
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<td>1.0% Steel Mixture Beads</td>
<td>D14-04I, D14-04J</td>
<td>1,110 L.F.</td>
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<td>Concrete Handlebars</td>
<td>D14-04K, D14-04L</td>
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<td>24 AWG Jumper Cable</td>
<td>D14-04M</td>
<td>1,360 L.F.</td>
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<td>3/8-144 Bare Ground Cables</td>
<td>D14-04N</td>
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<td>Drain Trench Insulation</td>
<td>D14-04O</td>
<td>4,200 L.F.</td>
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<td>Drain Spouts Insulation</td>
<td>D14-04P</td>
<td>1,540 L.F.</td>
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#### CONTROL BUILDING (LUMP SUM)

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<tr>
<td>Structure, including foundation, cast-in-place walls, floor slab, masonry walls, present &quot;flat&quot; homes, roof, doors, windows, etc.</td>
<td>D15-01A, D15-01B</td>
<td>1 Ex.</td>
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<tr>
<td>Electrical Work, including auxiliary transformer, panelboard, light fixtures, outlets, conduit, wire and miscellaneous equipment.</td>
<td>D15-01C</td>
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<tr>
<td>Plumbing Work, including water heater, - water meter, fixtures, pipes and miscellaneous equipment.</td>
<td>D15-01D</td>
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<td>Heating, Ventilating and Air Conditioning, including electrical panels and wall heater, air conditioning units, exhaust fans, ductwork and miscellaneous equipment.</td>
<td>D15-01E</td>
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#### TELEVISION SURVEILLANCE SYSTEM (LUMP SUM)

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<td>TV Cameras, including support post, auxiliary equipment, enclosure, control and miscellaneous equipment.</td>
<td>D16-01A, D16-01B</td>
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<td>Flexible Co-Axial Cable</td>
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<td>Control Cable 18/1</td>
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<td>Receiver/Monitor</td>
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<td>Control Console, including environmental,桠控制, control console equipment.</td>
<td>D16-01H</td>
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### GENERAL NOTES
NOTE A
6'-0" Chain Link Fence
with Gate each side and
Barbed Wire Top.
See Std. Dwg. P/TE 002 B
PFG 005, current edition.
Use 3" x 3" Nominal @
5.76 lb/ft posts

1 Opening for Air Intake Louver
2 Opening for Exhaust Fan and Shutter
See Sheet D12 for size and location

1" Recessed Panels (Typical)
Opening for Ladder
Tray - See Sheet DS
Precast Panel

56'-0" Splice to Fl13
19'-8"

116'-0" Splice to Fl, Fl0
64'-0"
NAMEPLATE SCHEDULE

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<tr>
<th>TYPE</th>
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<th>SUBSTATION NO.3</th>
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SIDE VIEW

COMMUNWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON

SIDE VIEW

SUBSTATION LAYOUT

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON

SIDE VIEW

SUBSTATION LAYOUT
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<tr>
<th>Substation Transformer</th>
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<td>Secondary Kva</td>
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<td>2</td>
<td>1000</td>
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<td>3</td>
<td>925</td>
<td>1942</td>
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<td>4</td>
<td>1500</td>
<td>2374</td>
<td>450/280V</td>
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<tr>
<td>5</td>
<td>1500</td>
<td>2239</td>
<td>358/220V</td>
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</tbody>
</table>

*Transformer current carrying circuits & parts*
NAMEPLATE
NUMBER | SUBSTATION NO. 1 | SUBSTATION NO. 2
DESCRIPTION | DESCRIPTION
--- | --- | ---
1 | SUBSTATION NO. 1, LOAD CENTER IA | SUBSTATION NO. 2 LOAD CENTER 2A
2 | CURRENT TEST BLOCK 2000/5A C.T. | CURR.
3 | VOLTAGE TEST BLOCK | VOLT
4 | AUXILIARY POWER PANEL | AUX.
5 | INTERCOM JACK | JACK
6 | PANEL 1A, MAIN CIRCUIT BREAKER | PANEL 2A, MAIN CIRCUIT BREAKER
7 | PANEL 1A, MAIN CIRCUIT BREAKER | PANEL 2A, MAIN CIRCUIT BREAKER
8 | PANEL 1A, MAIN CIRCUIT BREAKER | PANEL 2A, MAIN CIRCUIT BREAKER
9 | PANEL 1A, MAIN CIRCUIT BREAKER | PANEL 2A, MAIN CIRCUIT BREAKER
10 | PANEL BOARD 1A | PANEL BOARD 2A
11 | PANEL BOARD 1A | PANEL BOARD 2A
12 | PANEL BOARD 1A | PANEL BOARD 2A
13 | SUBSTATION NO. 2 LOAD CENTER IA | SUBSTATION NO. 2 LOAD CENTER 2B
14 | CURRENT TEST BLOCK 2000/5A C.T. | CURR.
15 | VOLTAGE TEST BLOCK | VOLT
16 | PANEL 1B, MAIN CIRCUIT BREAKER | PANEL 2B, MAIN CIRCUIT BREAKER
17 | PANEL 1B, MAIN CIRCUIT BREAKER | PANEL 2B, MAIN CIRCUIT BREAKER
18 | PANEL 1B, MAIN CIRCUIT BREAKER | PANEL 2B, MAIN CIRCUIT BREAKER
19 | PANEL BOARD 1B | PANEL BOARD 2B
20 | PANEL BOARD 1B | PANEL BOARD 2B
21 | PHASE A | PHASE A
22 | PHASE B | PHASE B
23 | PHASE C | PHASE C
24 | 480 CIRCUIT BREAKER AUXILIARY | 480 CIRCUIT BREAKER AUXILIARY

NOTE:
NAMEPLATES SHALL BE LAMINATED BLACK ON WHITE OR BLACK.
CHARACTERS SHALL BE CUT THRU THE BLACK LAMINATION.
EDGES OF NAMEPLATE SHALL BE BEVELED.
12' NEOPRENE PADS CENTERED UNDER LID JOINTS, 1/4" THICK
24" X 31/2" X 3/4"
BE. NT SPACED @ 4-0

CABLE GUND SECTION

SECTION AA
SCALE 1:2

NOTE:
1. All exposed metal parts shall be hot-dipped after fabrication in accordance with coating of two ounces per square foot of surface area. See Drawings

CONCRETE HANDHOLE DETAILS

COMM. OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF JEFFERSON
164-13TH ST TO 7TH ST LOUISVILLE - LEXINGTON
CONCRETE HANDHOLE PROJECT NO. SP 56-273-
P.E. PROJECT NO. 164-2(35)
MAINTEANCE PROJECT NO. 1850-7

REF. SHEETS: D00

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF JEFFERSON
164-13TH ST TO 7TH ST LOUISVILLE - LEXINGTON
CONCRETE HANDHOLE PROJECT NO. SP 56-273-
P.E. PROJECT NO. 164-2(35)
MAINTEANCE PROJECT NO. 1850-7

REF. SHEETS: D00
KET STREETS-APPROACH RAMPS No.1 & No.3

--- NOTES ---

NOTE No.1: SECTIONS "C" & "D" APPEAR ON SHEET D60

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE -LEXINGTON ROAD
SP 86-773-III.

HEATING CABLES RAMP 1 & RAMP 3 APPROACH

SHEET D45

[Diagram with various notes and measurements]
LONGITUDINAL CONSTRUCTION JOINT (2) CONSTRUCTION Joint Boxes SEE SHEET D-64

NOTES:

NOTE NO. 1 - SECTION 'A' APPEARS ON SHEET D-60

PERSON STREETS - RAMP NO. 4

ASSEMBLY NO. 1 - RAMP 4-2B (START) TO CONSTRUCT JOINT
ASSEMBLY NO. 2 - CONSTRUCT. JOINT TO END OF HOT SECTION
ASSEMBLY NO. 3 (COLD) - END OF HOT SECTION TO END TERMINATION BOX

HEATING CABLES RAMP 4 APPROACH

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON

264-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON

SHEET 049

STATION 208+00 P.E. PROJECT NO. 164-2.185.13

DEPARTMENT PROJECT NO. 16575
INTERSECTION AT NINTH STREET—RAMP NO. 2

SCALE:

---

D-58
END TERMINATION BOX FOR RAMP ON GRADE

SCALE - 9/16" = 1'
NOTE 1: THE HEATING CABLE SHALL BE CONSTRUCTED OF 1/2" X 1/2" X 1/2" BRONZE BAR STOCK OR A BRONZE CASTING ASTM B-22.

NOTE 2: USE 8/0 COPPER GROUND CABLE.

NOTE 3: USE 1/2" MOUNTING BARS WITH SPACE-DECAL.

SEE SUPPORT DETAIL "C" SHEET D-35.

SECTION "D" N.Y.S.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-166 ST TO FM ST
LOUISVILLE - LEXINGTON ROAD
STATION 206+06
P.E. PROJECT NO. 164-1703
CONSTRUCTION PROJECT NO.
MAINTENANCE PROJECT NO.
16575
BONDING BAR
SEE SHEET D61 FOR DETAILS

NYLON CRADLE
NEOPRENE CLIP

CRADLE & CLIP
DETAIL

SECURE TO 3/8 X 1/2 X 1/4 IN MOUNTING BAR WITH ROUNDED EDGES

INSULATED COMPRESSION CONNECTION

SECTION E-E
IN OR OUT UNIT

SECTION C-C
END UNIT

CRADLE & CLIP
SEE DETAIL THIS SHEET
SEE SHEET 030 FOR FEEDER GROUP SCHEDULE

SECTION F-F
START UNIT

SEE SHEET 032 FOR DETAILS OF PULLING FEEDER GROUPS

---

#6 GROUND CABLE FROM LOAD CENTER WITH COMPRESSION CONNECTION

#2/0 INSULATED GROUND CABLE

NYLON CABLE TIE

OPEN EXPANSION JOINT

INSULATING BUSHING

TWO HOLE STEEL CABLE STRAP

#6 CONDUCTOR LEAD WITH 600V INSULATING SLEEVE (TYPICAL)

POLYVINYLCHLORIDE PLASTIC TUBING

NOTES:
1. FIREPROOF ALL CABLES
2. ARRANGE LEADS SO AS TO FACILITATE THE USE OF A CLAMP ON AMMETER

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF JEFFERSON
164-184' ST. TO 7TH ST.
LOUISVILLE - LEXINGTON ROAD

HEATING CABLE
SECTIONS IV

STATION 300+08
PROJECT NO. 344-2 (555.5)
DRAWING NO. 0878

18575
DETAIL 1
SEE SHEETS D41 THRU D57

TYPICAL STEEL PLINTH UNIT
(8"x8" WIREWAY)
SEE SHEET D61

THIS SHEET
DRAIN

GROUND CABLE
SEE SHEET D65

TOP REINFORCEMENT BAR
(TYPICAL)

HEATING CABLES

SECTION A-A (THIS SHEET)

NOTES
1) ALL CONDUIT WITH FIBERGlass
THICKNESS 5/16"
2) OR SWG 8/6
3) ALL EXPOSED STEEL GALV
ACCORDINGLY HAVE A MINIMUM SQUARE FOOT
HEATING CABLE OPENING (LOCATION VARIES)

HOT TO COLD SECTION

TOP REINFORCEMENT BAR (TYPICAL)

HEATING CABLE

BOND 2/8 GROUND CABLE TO GROUND NUT OF STANDARD

TYPICAL STEEL PLINTH

UNIT (8' 6" x 9" D.I.W.

2" RIGID STEEL CONDUIT THROUGH SUPPORT BASE FOR JUMPER CABLES

1/4" N. S. C. GROUND CABLE TO LIGHT, TELEVISION OR WEATHER STATION

STANDARD GROUND CABLE

GROUND CABLE

SEE SHEET D62

SEE SHEET D61 THRU D57

INSULATION DETAIL

SCALE: 1/2" = 1'

3/8" AND DRAIN PIPES SHALL BE COVERED WITH 1/4" PIPE INSULATION, NOMINAL 2" OF THICK STAINLESS STEEL JACKET

ROUGH IS 6'/2", FABRICATE AS REQUIRED

2" METAL PARTS SHALL BE HOT DIPPED AFTER FABRICATED IN

WITH ASTM SPEC # A366 AND SHALL HAVE COATING OF 2 OUNCES PER

OF SURFACE AREA (ONE SIDE) APPLIED

HEATING CABLE

SECTIONS
PLAN VIEW OF CONSTRUCTION JOINT

SCALE: 1/4" = 1'-0"

CONSTRUCTION JOINT BOX

SECTION A-A

SCALE: 1/2" = 1'-0"

CONSTRUCTION JOINT

SEE NOTE 1 - THIS SHEET

HOT SECTION
SEE NOTE 1

COLD SECTION
SEE NOTE 2

CONSTRUCTION JOINT BOX

TIE BAR
**NOTES:**

1. BEFORE POURING CONCRETE IN 1ST SECTION, SET THE FIRST CONSTRUCTION JOINT BOX IN PLACE AND CONNECT MI CABLE AND SECURE TO FORM, THEN POUR SECTION.

2. AFTER CONCRETE HAS HARDENED, MAKE CONNECTIONS WITH OTHER CONSTRUCTION JOINT BOX MI CABLES, PUT GASKET IN PLACE AND BOLT TOGETHER. FILL BOX WITH WATERPROOF COMPOUND AND POUR NEXT SECTION.

3. HOLES FOR FIRST BOX TO BE DRILLED AND TAPPED FOR 1/4" X 20 BOLTS. HOLES FOR SECOND BOX TO BE DRILLED 9/32".
Example of procedure for the sequence of items to be connected:

1. Circuit Breaker 7, 8 & 9
2. Panel Board 4A1
3. Panel Board 4A3
4. Panel

Refer to sheets D07 thru D10
NOTE

ALL BRIDGE RAMP CABLE TRAININGS ARE SIMILAR TO THE ABOVE EXAMPLE. FOR LOCATION OF CABLE OPENING IN STEEL PUNTH UNIT SEE SHEET NO. D72.
EXCESS COLD SECTION CABLE TRAINING SEE DETAIL 2, SHEET D63.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
194-JOHNS ST TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD

STATION 208+00
CABLE OPENING
CABLE OPENING
DETAILS

CONTRACTOR PROJECT NO.
U.S. 231-21503
MAINTENANCE PROJECT NO.
DRAWING NO.
16575
<table>
<thead>
<tr>
<th>Annunciator Display Schedule</th>
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<tbody>
<tr>
<td><strong>Substation 1</strong></td>
</tr>
<tr>
<td>Transformer, Oil High Temp</td>
</tr>
<tr>
<td>Transformer, B</td>
</tr>
<tr>
<td>Trip on Aux. PB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substation 1</th>
<th>Substation 1</th>
<th>Substation 1</th>
<th>Substation 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer, Oil High Temp</td>
<td>Loadcenter, A</td>
<td>Loadcenter, B</td>
<td>Loadcenter, B</td>
</tr>
<tr>
<td>Transformer, B</td>
<td>Trip on PB-1A2</td>
<td>Trip on PB-1B2</td>
<td>Loadcenter, B</td>
</tr>
<tr>
<td>Trip on Aux. PB</td>
<td>Trip on PB-1B2</td>
<td>Trip on PB-1B2</td>
<td>Loadcenter, B</td>
</tr>
</tbody>
</table>

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<th>4</th>
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</tr>
</tbody>
</table>

TV - No. 1 Unit Removed
TV - No. 2 Unit Removed
TV - No. 3 Unit Removed
TV - No. 4 Unit Removed
TV - No. 5 Unit Removed
TV - No. 6 Unit Removed

Main Circuit Breaker Failed To Reclose
Step Voltage Regulator Oil High Temp
Low Liquid Level Pressure Relief

---

**COMMONWEALTH OF KENTUCKY**
**DEPARTMENT OF HIGHWAYS**

**COUNTY OF JEFFERSON**
164-19TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON ROAD
SP 56-277-11

**INSTRUMENT 8**
**CONTROL CABINET**
PLAN - DRAIN SIDE OF ROADWAY

SCHEDULE OF THERMOCOUPLES

<table>
<thead>
<tr>
<th>TOP THERMOCOUPLE</th>
<th>NO. 1 AND NO. 7</th>
<th>NO. 3 AND NO. 11</th>
<th>NO. 4 AND NO. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIDDLE THERMOCOUPLE</td>
<td>NO. 9</td>
<td>NO. 5</td>
<td>NO. 6</td>
</tr>
<tr>
<td>LOWER THERMOCOUPLE</td>
<td>NO. 9</td>
<td>NO. 5</td>
<td>NO. 6</td>
</tr>
</tbody>
</table>

NOTE:
FOR ALL THERMOCOUPLE STATION LOCATIONS SEE SHEET D3

THERMOCOUPLE LOCATIONS
SCALE: 5" x 1"-0"
WEATHER STATION PLAN VIEW

SCALE: 1/8" = 1'

NOTES:
1. WEATHER STATION #1 LOCATION SEE SHEET D3 & D4.
2. WEATHER STATION #2 LOCATION SEE SHEET D3 & D4.
3. WEATHER STATION #1 IS CONNECTED TO CONTROL SYSTEM & WEATHER STATION #2 SERVES AS BACK-UP, WITH ALL CABLES INSTALLED.
4. WIRING INSTRUCTIONS SEE SHEET D76 & D78.
5. WEATHER STATIONS TO BE SPACE TO MISS RAILING POSTS.

NOTE:
ALL EXPOSED METAL PARTS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATED IN ACCORDANCE WITH ASTM SPEC A307 AND SHALL HAVE A MINIMUM CURTIISING OF 2 OUNCES PER SQUARE FOOT OF SURFACE AREA (ONCE SIDE) APPLIED.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-17TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
WEATHER STATION DETAILS

STATION 208-D
PROJECT NO. 164-21569
DRAWING NO. 16578
### Module Definition

<table>
<thead>
<tr>
<th>Module</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Signal Converter</td>
<td>A device for changing a digital signal to an analog output</td>
</tr>
<tr>
<td>Set Point Trip</td>
<td>A device for detecting a set point which closes or opens a contact</td>
</tr>
<tr>
<td>Sample/ Hold</td>
<td>A device which samples an incoming signal and initiates a sample pulse</td>
</tr>
<tr>
<td></td>
<td>after the sample pulse is removed. The output remains at the sampled level until a new sample pulse is received</td>
</tr>
<tr>
<td>ADM/L Amplifier</td>
<td>A device which accumulates input signals. It provides a single output corresponding to the input amplitude</td>
</tr>
<tr>
<td>ADM/H</td>
<td>Same as above, but for positivegoing signals only</td>
</tr>
<tr>
<td>Subtractor</td>
<td>A device which subtracts input signals to determine the difference in magnitude of two input signals</td>
</tr>
</tbody>
</table>

### Notes

1. For location of detectors, see sheet D74.
2. For continuation of signal circuits, see sheet D77.
3. Power supply shall be provided to the respective devices. The supply is not shown completely on this sheet.
4. Refer to nameplate schedule sheet D73.
PRESENT SIGNALS

SLAB TEMPERATURE SIGNALS

OUTDOOR TEMPERATURE SIGNALS

PRECIPITATION SIGNALS

WIND DIRECTION SIGNALS

HUMIDITY SIGNALS

BAROMETRIC PRESSURE SIGNALS

WIND SPEED SIGNALS

LOGIC SYSTEM IN RESPONSE TO WEATHER CONDITIONS
### Loading Stations Preset Combination of We

<table>
<thead>
<tr>
<th>Event No.</th>
<th>Logic Diagram Symbol</th>
<th>Slab Temp. Pres. Set (x)</th>
<th>Outdoor Temp. Pres. Set</th>
<th>Outdoor Temp. Falling</th>
<th>Rain</th>
<th>Snowing</th>
<th>Wind Direction Pres. Set</th>
<th>Rd. 2.1 Pre-</th>
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<tr>
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<td>o</td>
<td>o</td>
<td>x</td>
<td>x</td>
<td>o</td>
<td>o</td>
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<td>9</td>
<td>o</td>
<td>x</td>
<td>x</td>
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<td>3</td>
<td>24</td>
<td>o</td>
<td>(x) x</td>
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<td>4</td>
<td>20</td>
<td>o</td>
<td>(x) x</td>
<td>x</td>
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<tr>
<td>5</td>
<td>18</td>
<td>(x) (x)</td>
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<tr>
<td>6</td>
<td>27</td>
<td>o</td>
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<td>17</td>
<td>(x) (x)</td>
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<td>10</td>
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<td>(x) (x)</td>
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<tr>
<td>11</td>
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<td>(x) (x)</td>
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</tbody>
</table>

**Legend:**
- o: No signal output from device
- x: Signal output from device
- [ ] Event occurs by 4Y or 5X remaining combination
- ( ) Event occurs by 4Y or 5X in combination with remaining 1
- ( ) ( ) Event occurs by 2T or 2R and 5X in combination
- X --> X Either 5X or 6Y

**Note:** Events 1 through 11 activate event reorder regardless of 1; however, the overall signal is affected by sunshine (even)

### Photo Cell Timing Cycle

<table>
<thead>
<tr>
<th>Contact</th>
<th>Time Sun Is Shining</th>
<th>TPI Timer Out</th>
<th>TM-2 Timing</th>
<th>Opening Reset</th>
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</thead>
<tbody>
<tr>
<td>L.G.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
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</tr>
<tr>
<td>P.G.1</td>
<td>[ ]</td>
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<tr>
<td>TPI</td>
<td>[ ]</td>
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<tr>
<td>R.C.</td>
<td>[ ]</td>
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<td>[ ]</td>
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<tr>
<td>T2.2</td>
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</table>

### Control Signal Recorder Schedule

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<tr>
<th>Point</th>
<th>Signal</th>
<th>Parameter</th>
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<tr>
<td>1</td>
<td>Slab Temperature</td>
<td>&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Combined Control</td>
<td>Control Signal Output</td>
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</table>

0) Nameplate - See Sheet DT3 for location. For circuit location see sheet DT8.
### TIMING CYCLE FOR SNOWING OVERRIDE

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<tr>
<th>CONTACTS</th>
<th>START TIMING</th>
<th>ABSENT TIMING</th>
<th>TIMING</th>
<th>ABSENT TIMING</th>
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</tbody>
</table>

#### NOTES FOR SHEET D78

- **Return Control Circuit R2-2** (R2-3) shall be interlocked to prevent the circuit from being subjected to overload. This allows time for the alarm to be activated when the power source is interrupted or prevented.

#### LEGEND FOR SHEET D78

- **PHOTO CELL**
- **PVM-1**
- **RELAY COIL**
- **NORMAL OPEN CONTACT**
- **NORMAL CLOSED CONTACT**
- **TERMINAL BLOCK**
- **AC AUXILIARY RELAY CONTACT**
- **SEE SHEET D22**
- **CONTACT ON MAIN AIR CIRCUIT BREAKER**
- **OPEN CIRCUIT BREAKER**
- **CLOSED CIRCUIT BREAKER**
- **HIGH VOLTAGE REGULATOR**
- **LOW VOLTAGE REGULATOR**
- **VOLTAGE REGULATOR**
- **SEYLSIN RECEIVER**
- **SEE SHEET D22**
- **RETURN CIRCUIT TO REGULATOR-TO-RAISE VOLTAGE**
- **RETURN CIRCUIT TO REGULATOR-TO-LOW VOLTAGE**
- **RETURN CIRCUIT FROM REGULATOR**
- **TELEPHONE JACK CIRCUIT**

#### COMMONWEALTH OF KENTUCKY

**DEPARTMENT OF HIGHWAYS**

**FRANKFORT**

**COUNTY OF JEFFERSON**

**164-13TH ST. TO 7TH ST**

**BRIDGE 209-09**

**PROJECT NO. 164-209**

**BRIDGE NUMBER** 18575
THERMOCOUPLE CONNECTION PANEL

SLAB TEMPERATURE CONTROL THERMOCOUPLE

TO RAMP 1

TO RAMP R4-III

TO RAMP R1-IV

TO RAMP R4-IV

TO RAMP R2A-III

SLAB TEMPERATURE PYROMETER

THERMOCOUPLE RECORDER

THERMOCOUPLE MULTIPLEX STRIP CHART RECORDER

UNDERLINED LETTERING INDICATES ENGRAVING SCHEDULE FOR RAMP THERMOCOUPLE SELECTOR PANEL ON SHEET D73
REFERENCE DRAWINGS:
FOR THERMOCOUPLE STATION LOCATIONS SEE SHEET D41-D69
FOR THERMOCOUPLE STATION DETAILS SEE SHEET D74
FOR THERMOCOUPLE RECORDER & TRANSMITTER & SELECTOR SWITCHES SEE SHEET D76

REFERENCE DRAWINGS:
FOR THERMOCOUPLE STATION LOCATIONS SEE SHEET D41-D69
FOR THERMOCOUPLE STATION DETAILS SEE SHEET D74
FOR THERMOCOUPLE RECORDER & TRANSMITTER & SELECTOR SWITCHES SEE SHEET D76

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-165TH ST TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
3B-275-HL
PROJECT NO.
18575

THERMOCOUPLE CONNECTION
PANEL WIRING DIAGRAM
LOAD CENTER
SECONDARY CURRENT

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VOLTMETER & AMMETER SWITCH CONTACT DIAGRAM

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TEN SWITCH TYPE IS MAKE BEFORE BREAK

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
STATION 208-08
PROJECT NO. 1627-08

LOAD CENTERS & SWITCHGEAR
INSTRUMENT WIRING DIAGRAMS