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

The contents of this report reflect the views of
the author who is responsible for the facts and
the accuracy of the data presented herein. The
contents do not necessarily reflect the official
views or policies of the Bureau of Highways
or the Federal Highway Administration.
This report does not constitute a standard,
specification, or regulation.

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 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 pros and cons of imbedded 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 indicate 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 lump sum bid items were as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<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-watt 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.
Photo Courtesy of Courier Journal
# AU OF HIGHWAYS
# N COUNTY
# LEXINGTON
# TO 7TH STREET

## HEATING

<table>
<thead>
<tr>
<th>SHEET NO</th>
<th>TITLE</th>
<th>SHEET NO</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 45</td>
<td>HEATING CABLES RAMP 1 &amp; RAMP 3 APPROACH</td>
<td>0 57</td>
<td>HEATING CABLE CIRCUITING I</td>
</tr>
<tr>
<td>0 46</td>
<td>HEATING CABLES UNIT PLANS R2-X</td>
<td>0 58</td>
<td>HEATING CABLE CIRCUITING II</td>
</tr>
<tr>
<td>0 47</td>
<td>HEATING CABLES UNIT PLANS R2-II</td>
<td>0 59</td>
<td>HEATING CABLE CIRCUITING III</td>
</tr>
<tr>
<td>0 48</td>
<td>HEATING CABLES UNIT PLANS R2-1 &amp; R2-2</td>
<td>0 60</td>
<td>HEATING CABLE CIRCUITING IV</td>
</tr>
<tr>
<td>0 49</td>
<td>HEATING CABLES UNIT PLANS R3-1 &amp; R3-16</td>
<td>0 61</td>
<td>CABLE OPENING DETAILS</td>
</tr>
<tr>
<td>0 50</td>
<td>HEATING CABLES UNIT PLANS R3-1 &amp; R3-16</td>
<td>0 62</td>
<td>CABLE OPENING SCHEDULE</td>
</tr>
<tr>
<td>0 51</td>
<td>HEATING CABLES UNIT PLANS R3-1 &amp; R3-16</td>
<td>0 63</td>
<td>INSTRUMENT &amp; CONTROL CABINET</td>
</tr>
<tr>
<td>0 52</td>
<td>HEATING CABLES UNIT PLANS R4-1 &amp; R4-10</td>
<td>0 64</td>
<td>THERMOCOUPLE DETAILS</td>
</tr>
<tr>
<td>0 53</td>
<td>HEATING CABLES UNIT PLANS R4-13</td>
<td>0 65</td>
<td>WEATHER STATION DETAILS</td>
</tr>
<tr>
<td>0 54</td>
<td>HEATING CABLES UNIT PLANS R4-13</td>
<td>0 66</td>
<td>RAMP HEATING CONTROL DIAGRAM I</td>
</tr>
<tr>
<td>0 55</td>
<td>HEATING CABLES UNIT PLANS R4-13</td>
<td>0 67</td>
<td>RAMP HEATING CONTROL DIAGRAM II</td>
</tr>
<tr>
<td>0 56</td>
<td>HEATING CABLES UNIT PLANS R4-13</td>
<td>0 68</td>
<td>RAMP HEATING CONTROL DIAGRAM III</td>
</tr>
<tr>
<td>0 57</td>
<td>HEATING CABLES UNIT PLANS R4-13</td>
<td>0 69</td>
<td>RAMP HEATING CONTROL DIAGRAM IV</td>
</tr>
<tr>
<td>0 58</td>
<td>RAMP 2 APPROACH &amp; END TERMINATION BOX DETAILS</td>
<td>0 70</td>
<td>ANNUNCIATION WIRING DIAGRAM</td>
</tr>
<tr>
<td>0 59</td>
<td>HEATING CABLE SECTIONS I</td>
<td>0 71</td>
<td>THERMOCOUPLE CONNECTING PANEL WIRING DIAGRAM</td>
</tr>
<tr>
<td>0 60</td>
<td>HEATING CABLE SECTIONS II</td>
<td>0 72</td>
<td>LOAD CENTER &amp; SWITCHGEAR INSTRUMENT WIRING DIAGRAM</td>
</tr>
<tr>
<td>0 61</td>
<td>HEATING CABLE SECTIONS III</td>
<td>0 73</td>
<td>INTERCOM SYSTEM</td>
</tr>
<tr>
<td>0 62</td>
<td>HEATING CABLE SECTIONS IV</td>
<td>0 74</td>
<td>TELEVISION SYSTEM SCHEMATIC</td>
</tr>
<tr>
<td>0 63</td>
<td>HEATING CABLE SECTIONS V</td>
<td>0 75</td>
<td>TELEVISION SYSTEM DETAILS</td>
</tr>
<tr>
<td>0 64</td>
<td>TYPICAL SPICE AT CONSTRUCTION JOINT</td>
<td>0 76</td>
<td>TELEVISION SECTIONS VIEWS I</td>
</tr>
<tr>
<td>0 65</td>
<td>GROUNDING DETAIL PLAN</td>
<td>0 77</td>
<td>TELEVISION SECTIONS VIEWS II</td>
</tr>
<tr>
<td>0 66</td>
<td>HEATING CABLE CIRCUITING I</td>
<td>0 78</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 67</td>
<td>HEATING CABLE CIRCUITING II</td>
<td>0 79</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 68</td>
<td>HEATING CABLE CIRCUITING III</td>
<td>0 80</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 69</td>
<td>HEATING CABLE CIRCUITING IV</td>
<td>0 81</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 70</td>
<td>HEATING CABLE CIRCUITING V</td>
<td>0 82</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 71</td>
<td>HEATING CABLE CIRCUITING VI</td>
<td>0 83</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 72</td>
<td>HEATING CABLE CIRCUITING VII</td>
<td>0 84</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 73</td>
<td>HEATING CABLE CIRCUITING VIII</td>
<td>0 85</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 74</td>
<td>HEATING CABLE CIRCUITING IX</td>
<td>0 86</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 75</td>
<td>HEATING CABLE CIRCUITING X</td>
<td>0 87</td>
<td>QUUTI DETAILS</td>
</tr>
<tr>
<td>0 76</td>
<td>HEATING CABLE CIRCUITING XI</td>
<td>0 88</td>
<td>QUUTI DETAILS</td>
</tr>
</tbody>
</table>

*Note:* Drawings for entire project to be divided as follows:
- Sheet Prefix: A, B, C, D
- Sheet No: 010, 020, 030, 040
- Structures and Substructure:
  - A: Mainline - Substructure
  - B: Mainline - Deck
  - C: Ramps - Substructure
  - D: Ramps - Superstructure
- General Notes and Estimated Quantities see Sheet 06.

*These Sheets are numbered 1 thru 89 The total number of Sheets is 89 which includes Sheet D7A.*
### LIST OF MATERIALS FOR RAMP HEATING

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

<table>
<thead>
<tr>
<th>Estimated Quantity</th>
<th>Description</th>
<th>Reference Sheet No.</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,336 Ex.</td>
<td>Heating Cable Assembly for Bridge Ramps</td>
<td>D61-048, D61-090, D61-102, D61-151</td>
<td>2 Ex.</td>
</tr>
<tr>
<td>455 Ex.</td>
<td>Heating Cable Assembly for On-Grade Ramps</td>
<td>D61-048, D61-102, D61-151</td>
<td>5,300 L.F.</td>
</tr>
<tr>
<td>1,010 L.F.</td>
<td>8&quot; x 12&quot; Steel Ramps</td>
<td>D61-048, D61-102</td>
<td>2 Ex.</td>
</tr>
<tr>
<td>190 L.F.</td>
<td>Concrete Handholes</td>
<td>D61-048, D61-102</td>
<td>1 Ex.</td>
</tr>
<tr>
<td>32,010 L.F.</td>
<td>Welded Jumper Cable</td>
<td>D61-048, D61-102</td>
<td>17 Ex.</td>
</tr>
<tr>
<td>4,200 L.F.</td>
<td>Drain Trench Insulation</td>
<td>D61-048, D61-102</td>
<td>1 Ex.</td>
</tr>
<tr>
<td>1,540 L.F.</td>
<td>Grill Covering Insulator</td>
<td>D61-048, D61-102</td>
<td>1 Ex.</td>
</tr>
</tbody>
</table>

**CONTROL BUILDING (LUMP SUM)**

<table>
<thead>
<tr>
<th>Estimated Quantity</th>
<th>Description</th>
<th>Reference Sheet No.</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ex.</td>
<td>Structure, including foundation, cast-in-place walls, floor slab, masonry walls, preset &quot;slab&quot; room, roof, doors, windows, etc.</td>
<td>D12-010, D12-018</td>
<td>6 Ex.</td>
</tr>
<tr>
<td>1 Lot</td>
<td>Electrical Work, including utility transformers, panelboards, light fixtures, outlets, conduit, wire and miscellaneous equipment</td>
<td>D10</td>
<td>50 L.F.</td>
</tr>
<tr>
<td>1 Lot</td>
<td>Plumbing Work, including water heater - water heater, fixtures, pipe and miscellaneous equipment</td>
<td>D12</td>
<td>273 L.F.</td>
</tr>
<tr>
<td>1 Lot</td>
<td>Heating, Ventilation and Air Conditioning, including electrical panelboard and wall heaters, air conditioning units, exhaust fans, ductwork and miscellaneous equipment</td>
<td>D11</td>
<td>1 Ex.</td>
</tr>
</tbody>
</table>

**TELEVISION SURVEILLANCE SYSTEM (LUMP SUM)**

<table>
<thead>
<tr>
<th>Estimated Quantity</th>
<th>Description</th>
<th>Reference Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ex.</td>
<td>TV Camera, including support post, auxiliary equipment enclosure, antitheft and miscellaneous equipment</td>
<td>D64-045</td>
</tr>
<tr>
<td></td>
<td>Flexible Co-Axial Cable</td>
<td>D64, 06</td>
</tr>
<tr>
<td></td>
<td>Triple Co-Axial Cable</td>
<td>D64, 06</td>
</tr>
<tr>
<td></td>
<td>Control Cable 2/L</td>
<td>D64, 05</td>
</tr>
<tr>
<td></td>
<td>Central Cable (18 pairs)</td>
<td>D64, 05</td>
</tr>
<tr>
<td></td>
<td>Receiver/Master</td>
<td>D64, 05</td>
</tr>
<tr>
<td></td>
<td>Central Console, including environmental, support beam control equipment</td>
<td>D64, 05</td>
</tr>
</tbody>
</table>

---

**GENERAL NOTES**

---

**COMMONWEALTH OF KENTUCKY**
**DEPARTMENT OF HIGHWAYS**
**FRANKFORT**
**COUNTY OF JEFFERSON**
**264-105 th St. to 7th St.**
**LOUISVILLE - LEXINGTON ROAD**
**SP-08-201**
**STATE 264-06**
**P.O. PROJECT NO. 246-3 (361)**
**INFORMATION PROJECT NO.**

**48575**
NOTE A
8'-0" Chain Link Fence
with Gate each side and
Barbed Wire Top.
See Std. Dwg. DTC-001-3
Use 3" x 6" Nominat at
5.79 lb/ft posts

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

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

56'-0" Splice to FI3
19'-8"

125'-0" Splice to FI, FI0
64'-8"

1" Recessed Panel

D-15
TYPICAL PIER RISER DETAIL

6" 8" LADDER TRAY (SEE SHEET 0-40)
PRECAST CONG. T-BEAM
WEATHERPROOF CABLE & TRUNK ENTRANCE
SUSPENDED CABLE IN CONTROL BLDG. DWARK

SECTION L

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
104-105th ST TO 7th ST
LOUISVILLE - LEXINGTON
ROAD

NOTE: ALL CONDUITS UNDER STRUCTURE ARE TO BE BURIED IN STEEL (USE LONG RADIAL BENDS)
### NAMEPLATE SCHE

<table>
<thead>
<tr>
<th>NAMEPLATE NUMBER</th>
<th>SUBSTATION NO. 1 DESCRIPTION</th>
<th>SUBSTATION NO. 2 DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SUBSTATION NO. 1 LOAD CENTER IA</td>
<td>SUBSTATION NO. 2 LOAD CENTER IA</td>
</tr>
<tr>
<td>2</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
<td>VOLTAGE TEST BLOCK 2000/5A C.T.</td>
</tr>
<tr>
<td>3</td>
<td>VOLTAGE TEST BLOCK</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
</tr>
<tr>
<td>4</td>
<td>AUXILIARY POWER PANEL</td>
<td>AUXILIARY POWER PANEL</td>
</tr>
<tr>
<td>5</td>
<td>INTERCOM JACK</td>
<td>INTERCOM JACK</td>
</tr>
<tr>
<td>6</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>7</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>8</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
<td>PANEL 1A MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>9</td>
<td>PANEL BOARD 1A2</td>
<td>PANEL BOARD 1A2</td>
</tr>
<tr>
<td>10</td>
<td>PANEL BOARD 1A3</td>
<td>PANEL BOARD 1A3</td>
</tr>
<tr>
<td>11</td>
<td>SUBSTATION NO. 1 LOAD CENTER 1B</td>
<td>SUBSTATION NO. 2 LOAD CENTER 2A</td>
</tr>
<tr>
<td>12</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
<td>VOLTAGE TEST BLOCK 2000/5A C.T.</td>
</tr>
<tr>
<td>13</td>
<td>VOLTAGE TEST BLOCK</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
</tr>
<tr>
<td>14</td>
<td>PANEL 1B1 MAIN CIRCUIT BREAKER</td>
<td>PANEL 1B1 MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>15</td>
<td>PANEL 1B2 MAIN CIRCUIT BREAKER</td>
<td>PANEL 1B2 MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>16</td>
<td>PANEL 1B3 MAIN CIRCUIT BREAKER</td>
<td>PANEL 1B3 MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>17</td>
<td>PANEL BOARD 1B1</td>
<td>PANEL BOARD 1B1</td>
</tr>
<tr>
<td>18</td>
<td>PANEL BOARD 1B2</td>
<td>PANEL BOARD 1B2</td>
</tr>
<tr>
<td>19</td>
<td>PANEL BOARD 1B3</td>
<td>PANEL BOARD 1B3</td>
</tr>
<tr>
<td>20</td>
<td>PHASE A</td>
<td>PHASE A</td>
</tr>
<tr>
<td>21</td>
<td>PHASE B</td>
<td>PHASE B</td>
</tr>
<tr>
<td>22</td>
<td>PHASE C</td>
<td>PHASE C</td>
</tr>
<tr>
<td>23</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
</tr>
<tr>
<td>24</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
</tr>
</tbody>
</table>

**NOTE:**
- NAMEPLATES SHALL BE LAMINATED BLACK ON WHITE ON BLACK.
- CHARACTERS SHALL BE CUT THRU THE BLACK LAMINATION.
- EDGES OF NAMEPLATE SHALL BE BEVELED.
LOAD CENTER B

(TYPICAL)

DUFF FOR SUBSTATIONS

<table>
<thead>
<tr>
<th>SUBSTATION NO. 3</th>
<th>SUBSTATION NO. 4</th>
<th>SUBSTATION NO. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>DESCRIPTION</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>ATION NO. 3 LOAD CENTER 3A</td>
<td>SUBSTATION NO. 4 LOAD CENTER 4A</td>
<td>SUBSTATION NO. 5 LOAD CENTER 5A</td>
</tr>
<tr>
<td>110 VOLT TEST BLOCK 2000/5A C.T.</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
<td>CURRENT TEST BLOCK 1500/5A C.T.</td>
</tr>
<tr>
<td>AUXILIARY POWER PANEL</td>
<td>INTERCOM JACK</td>
<td>AUXILIARY POWER PANEL</td>
</tr>
<tr>
<td>3A1 MAIN CIRCUIT BREAKER</td>
<td>PANEL 4A1 MAIN CIRCUIT BREAKER</td>
<td>PANEL 5A1 MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>BOARD 3A1</td>
<td>PANELBOARD 4A1</td>
<td>PANELBOARD 5A1</td>
</tr>
<tr>
<td>BOARD 3A2</td>
<td>PANELBOARD 4A2</td>
<td>PANELBOARD 5A2</td>
</tr>
<tr>
<td>BOARD 3A3</td>
<td>PANELBOARD 4A3</td>
<td>PANELBOARD 5A3</td>
</tr>
<tr>
<td>ATION NO. 3 LOAD CENTER 3B</td>
<td>SUBSTATION NO. 4 LOAD CENTER 4B</td>
<td>SUBSTATION NO. 5 LOAD CENTER 5B</td>
</tr>
<tr>
<td>110 VOLT TEST BLOCK 1500/5A C.T.</td>
<td>CURRENT TEST BLOCK 2000/5A C.T.</td>
<td>CURRENT TEST BLOCK 1500/5A C.T.</td>
</tr>
<tr>
<td>AUXILIARY POWER PANEL</td>
<td>INTERCOM JACK</td>
<td>AUXILIARY POWER PANEL</td>
</tr>
<tr>
<td>3B1 MAIN CIRCUIT BREAKER</td>
<td>PANEL 4B1 MAIN CIRCUIT BREAKER</td>
<td>PANEL 5B1 MAIN CIRCUIT BREAKER</td>
</tr>
<tr>
<td>BOARD 3B1</td>
<td>PANELBOARD 4B1</td>
<td>PANELBOARD 5B1</td>
</tr>
<tr>
<td>BOARD 3B2</td>
<td>PANELBOARD 4B2</td>
<td>PANELBOARD 5B2</td>
</tr>
<tr>
<td>BOARD 3B3</td>
<td>PANELBOARD 4B3</td>
<td>PANELBOARD 5B3</td>
</tr>
<tr>
<td>A</td>
<td>PHASE A</td>
<td>PHASE A</td>
</tr>
<tr>
<td>B</td>
<td>PHASE B</td>
<td>PHASE B</td>
</tr>
<tr>
<td>C</td>
<td>PHASE C</td>
<td>PHASE C</td>
</tr>
<tr>
<td>CIRCUIT BREAKER AUXILIARY</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
<td>480 CIRCUIT BREAKER AUXILIARY</td>
</tr>
</tbody>
</table>

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
144-131 ST. TO 77TH ST.
LOUISVILLE - LEXINGTON ROAD
SP 96-2733
SUBSTATION NAMEPLATE SCHEDULE
STATION 208-08
P.E. PROJECT NO. 164-1 (1501)
CONSTRUCTION PROJECT NO. 18678
12" NEOPRENE PADS CENTERED UNDER LID JOINTS, 1/4" THICK
4 1/2" X 3/8" R
2 3/4" X 3/8" R
2" X 1/4" BENT R
SPACED @ 4'-0"

CABLE COLD SECTION
BONDING BAR SEE SHEET D61

SHOULDERED NUT RING BOLT 3/8"
#8 BAR BY 8' LONG SPACED ON 6' CENTERS
4 1/2" X 2" X 3/8" R
#4 BAR (TYP)

SECTION A-A
SCALE: 1/2" = 1'

NOTE:
ALL EXPOSED METAL PARTS SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASTM SPEC. A386 AND SHALL HAVE A MINIMUM COATING OF 2 OUNCES PER SQUARE FOOT OF SURFACE AREA (ONE SIDE) APPLIED.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
254-10TH ST TO 7TH ST
LOUISVILLE - LEXINGTON ROAD
CONCRETE HANDHOLE DETAILS

STATION 208+06
P. E. PROJECT NO. 164-21911
SHEET D36
16579
<table>
<thead>
<tr>
<th>RAMP</th>
<th>NUMBER OF CABLES</th>
<th>LENGTHS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SHORT</td>
<td>AVG</td>
</tr>
<tr>
<td>R1-12</td>
<td>6.5</td>
<td>106.5</td>
<td>124.1</td>
</tr>
<tr>
<td>R1-13</td>
<td>6.5</td>
<td>121</td>
<td>124.1</td>
</tr>
</tbody>
</table>

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
244-16TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD

HEATING CABLES UNIT
PLANS R1-Y & R1-WI

SHEET D.44

STATION 208+08
CONSTRUCTION PROJECT NO. 164-2 (05)3

P.K. PROJECT NO. 164-2 (05)3

MAINTENANCE PROJECT NO. 18675
NOTES:

NOTE NO. 1 - SECTION "B" APPEARS ON SHEET D-60

PERSON STREETS - RAMP NO. 4

SCALE:

ABEEMIUN RAMP 4-28 (END)
SEE SHEET D-39

ABEEMILY RAMP 4-28 (END)
SEE SHEET D-39

HEATING CABLES
RAMP 4 APPROACH

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
264-13TH ST. TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
P+966-975-411
P. E. PROJECT NO. 164-2-135/3
CONSTRUCTION PROJECT NO. 16575

SHEET D-49
STEEL PLANT UNIT
R-12-4B (START)

63 HEATING CABLES
SEE SPACING ON
SECTION A5, SHEET D59

(4) THERMOCOUPLES
(5) THERMOCOUPLES
THERMOCOUPLE SERVICE POINT 5'DIA.
THERMOCOUPLE JUNCTION BOX TC-4B
SEE SHEET D74
STATION 12+49-734

T R4-IV SUPERSTRUCTURE

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
184-187 ST. TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
STATION 208+08
P.L. PROJECT NO. 164-21300
CONSTRUCTION PROJECT NO.
MAINTENANCE PROJECT NO.
DRAWING NO. 18575
END TERMINATION BOX FOR RAMP ON GRADE

SCALE: 1/8" = 1'

- 6/8" CABLE
- GROOVE WELD
- NITRILE GASKET
- 1" PIPE PLUG
- 1/4-20 BOLTS
- EXOTHERMIC WELD
- GROUND CABLE

SECTION A

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-1ST ST. TO 7TH ST.
LOUISVILLE - LEXINGTON ROAD

RAMP 2 APPROACH & END TERMINATION BOX

STATION 208+00
P.E. PROJECT NO. 164-2 (03)
CONTRACTOR PROJECT NO. 56-275 (IL)
1/8" Coppers Ground Cable

Exothermic Weld

2 3/4" Holes Required For Mounting to Construction Form, Drill (4)

Drill 3/8" x 1 3/8" (2) Each Bar for Line Connections

Indicates Heating Cable Cold Section Terminating Leads Trained into Bonding Bar for Construction Only.

Front View of Bonding Bar

Partial Top View of Bonding Bar

1/8" Round on All Exposed Edges as Indicated

Section 2"
BONDING BAR
SEE SHEET D61 FOR DETAILS

NYLON CRADLE

NEOPRENE CLIP

SECURE TO 1/4 X 1/4 X 1/4" MOUNTING BAR WITH ROUNDED EDGES

CRADLE & CLIP DETAIL

INSULATED COMPRESSION CONNECTION

SECTION E-E
IN OR OUT UNIT

CRADLE & CLIP SEE DETAIL THIS SHEET

SECTION C-C
END UNIT
#6 GROUND CABLE FROM LOAD CENTER WITH COMPRESSION CONNECTION

SEE SHEET 030 FOR FEEDER GROUP SCHEDULE

SECTION F-F
START UNIT

SEE SHEET 032 FOR DETAILS OF PULLING FEEDER GROUPS

INSULATING BUSHING
#2/C INSULATED GROUND CABLE
TWO HOLE STEEL CABLE STRAP
POLYVINYLCHLORIDE PLASTIC TUBING

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

NOTES:
1. FIREPROOF ALL CABLES
2. ARRANGE LEADS SO AS TO FACILITATE THE USE OF A CLAMP ON AMMETER
DETAIL 1
SEE SHEETS D41 THRU D57

DRINK

TOP REINFORCEMENT BAR (TYPICAL)

GROUND CABLE

SECTION A-A (THIS SHEET)

NOTES
1) ALL CONNS/PPOU WITH FIBER II THICK WITH C
2) OAM SPAN 20-6
3) ALL EXPOSE DIPPED GALV.
   ACCORDANCE HAVE A MINIMUM SQUARE ROOT
HEATING CABLE OPENING (LOCATION VARIES)

HOT TO COLD SECTION

TOP REINFORCEMENT BAR (TYPICAL)

HEATING CABLE

TYPICAL LIGHT TELEVISION OR WEATHER STATION STANDARDS

BOND 3/4" GROUND CABLE TO GROUND NUT OF STANDARD

TOP OF PLINTH

TOP OF CURB W/JUNCTION BOX

TOP OF ROADBED

TYPICAL STEEL PLINTH UNIT (6' X 6' W/2 X 4"")

2" RIGID STEEL CONDUIT THROUGH SUPPORT BASE FOR JUMPER CABLES

1/4" DARE COPPER GROUND CABLE TO LIGHT, TELEVISION OR WEATHER STATION STANDARD GROUND CABLE

GROUND CABLE SEE SHEET D65 & SHEET D62.

DETAIL "A"

SEE SHEETS D41 THEN D57

THRU DS7

THE B) CABLES WILL COVER LOCATIONS G AND THE DRAIN INLETS.

CABLE SECURE DETAIL

M1 HEATING CABLE

REINFORCEMENT BAR

14 GAUGE STAINLESS STEEL WIRE, SECURE CABLE COVER TO REINFORCEMENT BAR.

INSULATION DETAIL

SCALE: 1/2" = 1'

5" AND DRAIN PIPES SHALL BE COVERED BY PIPE INSULATION, NOMINAL 1/2" OF THICK STAINLESS STEEL JACKET.

ROUGH IS 67°C, FABRICATE AS REQUIRED.

METAL PARTS SHALL BE HOT DIP GALVANIZED ACCORDING TO 15-73-A (ASME). REMOVE GALVANIZER WITH MILL SCALE.

4" X 5" STUDS AND NUTS

3/4" BENT & DRAIN TROUGH (X 3/4") (GALVANIZED)

CURVE TO FOLLOW GUTTER LINE

AIR SPACE

5% FLEXIBLE FOAM PLASTIC INSULATION SHEET, SECURE TO 14 GA COVER WITH MANUFACTURER'S RECOMMENDED ADHESIVE.

14 GAUGE GALVANIZED STEEL COVER

INSTRUMENT DETAIL

SCAL:

1/2" = 1'

“S AND DRAIN PIPES SHALL BE COVERED BY INSULATION, NOMINAL 1/2" OF THICK STAINLESS STEEL JACKET.

ROUGH IS 67°C, FABRICATE AS REQUIRED.

METAL PARTS SHALL BE HOT DIP GALVANIZED ACCORDING TO 15-73-A (ASME). REMOVE GALVANIZER WITH MILL SCALE.

4" X 5" STUDS AND NUTS

3/4" BENT & DRAIN TROUGH (X 3/4") (GALVANIZED)

CURVE TO FOLLOW GUTTER LINE

AIR SPACE

5% FLEXIBLE FOAM PLASTIC INSULATION SHEET, SECURE TO 14 GA COVER WITH MANUFACTURER'S RECOMMENDED ADHESIVE.

14 GAUGE GALVANIZED STEEL COVER

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
164-13TH ST. TO 7TH ST.
LOUISVILLE-LEXINGTON ROAD
STATION 208+08
PROJECT NO. 764-12382
BRIDGE DRAWING NO. 18575

HEATING CABLE

SECTIONS V
PLAN VIEW OF CONSTRUCTION JOINT

SCALE: 1/8" = 1'-0"

SECTION A-A

SCALE: 1/3" = 1'-0"

CONSTRUCTION JOINT BOX

MOUNTING STRIP

CONSTRUCTION JOINT BOX

TIE BAR

SECTION A-A

B-49
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. HOT SECTION DIAMETER IS 3.5.
COLD SECTION DIAMETER IS 340.

4. HOLES FOR FIRST BOX TO BE DRILLED AND TAPPED FOR 1/4"X20 BOLTS.
HOLES FOR SECOND BOX TO BE DRILLED 9/32"
CABLE TRAINING

NOTE

ALL BRIDGE RAMP CABLE TRAININGS ARE SIMILAR TO THE ABOVE EXAMPLE. FOR LOCATION OF CABLE OPENING IN STEEL PUNCH UNIT SEE SHEET NO. D72. EXCESS COLD SECTION CABLE TRAINING SEE DETAIL 2 SHEET D63.
PLAN - DRAIN SIDE OF ROADWAY

RE-BARS (TYPICAL)

PLAN - CENTER

SCHEDULE OF THERMOCOUPLES

<table>
<thead>
<tr>
<th>TOP THERMOCOUPLE</th>
<th>MIDDLE THERMOCOUPLE</th>
<th>LOWER THERMOCOUPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO. 1 AND NO. 2</td>
<td>NO. 3 AND NO. 4</td>
<td>NO. 5 AND NO. 6</td>
</tr>
</tbody>
</table>

NOTE:

FOR ALL THERMOCOUPLE STATION LOCATIONS SEE SHEET 03
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
COUNTY OF
JEFFERSON
264-13TH ST TO 7TH ST.
LOUISVILLE - LEXINGTON
ROAD
SP 56-575-HL
P.O. PROJECT NO. 166-139-13
STATION 208+08
CONSTRUCTION PROJECT NO. 166-2-13
MAINTENANCE PROJECT NO. 16575
WEATHER STATION PLAN VIEW

SCALE: 1/4" = 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 INFORMATION SEE SHEET D4 & 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. A 385 AND SHALL HAVE A MINIMUM CORROSION OF 2 OUNCES PER SQUARE FOOT OF SURFACE AREA (ONCE SIDE) APPLIED.
PRE-SET SIGNALS

SLAB TEMPERATURE SIGNALS

OUTDOOR TEMPERATURE SIGNALS

PRECIPITATION SIGNALS

WIND DIRECTION SIGNALS

HUMIDITY SIGNALS

BAROMETRIC PRESSURE SIGNALS

WIND SPEED SIGNALS

CONT. FROM SHEET D7G

LOGIC SYSTEM IN RESPONSE TO WEATHER CONDITIONS
FOR ASSOCIATED RELAY CONTACTS SEE SHEET D73

LEGEND

<table>
<thead>
<tr>
<th>NEMA SYMBOL</th>
<th>LOGIC FUNCTIONS</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RELAY CONTACT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SIGNAL CONVERTER</td>
<td>A DEVICE FOR CHANGING A PILOT SIGNAL TO A LOGIC INPUT</td>
</tr>
<tr>
<td></td>
<td>NOR</td>
<td>A DEVICE WHICH PRODUCES AN OUTPUT ONLY WHEN ALL INPUTS ARE ABSENT</td>
</tr>
<tr>
<td></td>
<td>AND</td>
<td>A DEVICE WHICH PRODUCES AN OUTPUT ONLY WHEN ALL INPUTS ARE PRESENT</td>
</tr>
<tr>
<td></td>
<td>NOT</td>
<td>A DEVICE WHICH PRODUCES AN OUTPUT ONLY WHEN THE INPUT IS ABSENT</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>A DEVICE WHICH PRODUCES AN OUTPUT WHEN ONE INPUT (OR MORE) IS PRESENT</td>
</tr>
<tr>
<td></td>
<td>AMPLIFIER</td>
<td>A DEVICE IN WHICH AN INPUT SIGNAL CONTROLS A LOCAL SOURCE OF POWER TO PRODUCE AN OUTPUT GREATER THAN THE INPUT</td>
</tr>
<tr>
<td></td>
<td>RELAY COIL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EQUAL TO OR LESS THAN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EQUAL TO OR GREATER THAN</td>
<td></td>
</tr>
</tbody>
</table>

NOTES

1) FOR LOGIC DEFINITION SEE THIS SHEET & D76
2) POWER SUPPLY SOURCES NOT SHOWN
Typ for two photo cells located at weather stations with selector switch in instrument control case. Relay contacts actuated by the respective relay coils shown on logic system sheet D 77.

Loading stations 1 (preset combination of weather conditions)

For timing cycle see sheet D 78.

Control signal recorder, schedule see p 79.

Regulator reset

R2, R3, R4, R5, R6

Summer lock-out

SR-1, SR-2

Back-up power supply

12 unit power supply
### Table: Loading Station Preset Combination

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>O</td>
<td>X</td>
<td>X</td>
<td>4X</td>
<td>4Y</td>
<td>5X</td>
<td>5Y</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td></td>
<td>(X)</td>
<td>X</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td></td>
<td>(X)</td>
<td>X</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td></td>
<td>(X)</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>27</td>
<td>O</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>36</td>
<td></td>
<td>X</td>
<td>X</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td></td>
<td>(X)</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td></td>
<td>(X)</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>21</td>
<td></td>
<td>(X)</td>
<td>(X)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Legend
- O: No signal output from device
- X: Signal output from device
- □: Event occurs by 41 or 42, remaining combination
- ( ) Event occurs by 41 or 42 in combination with remaining
- ( ) ( ) Event occurs by 41 or 42 and 5X in combination w/RI
- X➔X: Either 9X or 5Y

Note: Events 1 through 11 actuate event recorder regardless of 1 however the overall signal is affected by sunshine (even

### Photo Cell Timing Cycle

<table>
<thead>
<tr>
<th>Contact</th>
<th>Time Signal Rising</th>
<th>Time Thermostat</th>
<th>Time Cell Timing</th>
<th>Opening Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.C.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P.G.1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>T.P1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>R.C.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>T.M.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>T.R.2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Control Signal Recorder Schedule

<table>
<thead>
<tr>
<th>Point</th>
<th>Signal</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<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>
</tr>
</tbody>
</table>

0) Nameplate: See Sheet D73 for location.
1) For circuit location see Sheet D78
### TIMING CYCLE FOR SNOWING OVERRIDE

<table>
<thead>
<tr>
<th>CONTACTS</th>
<th>START DURING TIMING</th>
<th>ENDURING TIMING</th>
<th>DURING REGULATOR</th>
<th>DURING REGULATOR</th>
<th>REGULATOR RESET</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TM3a</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TM3b</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TM4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RC1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RC2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RC3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RC4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### NOTES FOR SHEET D78

RETURN CONTROL CIRCUIT RC2-2 (RC2-3) SHALL BE INTERLOKED AT REGULATOR TO DELAY COMPLETION (HUGE) OR LOWER SIGNAL CIRCUIT COMPLETION. THIS ALLOWS TIME FOR REGULATOR OPERATOR INITIATED BY THE PREVIOUS SIGNAL.
THERMOCOUPLE CONNECTION PANEL

SLAB TEMPERATURE CONTROL THERMOCOUPLE

THERMOCOUPLE STATION TC-1A
1 2 3 4 5 6 7 8 9 10 11 12

TO RAMP 1

THERMOCOUPLE STATION TC-2A
1 2 3 4 5 6 7 8 9 10 11 12

TO RAMP R4-II

THERMOCOUPLE STATION TC-3A
1 2 3 4 5 6 7 8 9 10 11 12

TO RAMP R4-III

THERMOCOUPLE STATION TC-4A
1 2 3 4 5 6 7 8 9 10 11 12

TO RAMP R4-IV

THERMOCOUPLE STATION TC-5A
1 2 3 4 5 6 7 8 9 10 11 12

TO RAMP R2A-II

SLAB TEMPERATURE PYROMETER

THERMOCOUPLE RECODER

THERMOCOUPLE MULTIPONT STRIP CHART RECORDER

UNDERLINED LETTERING INDICATES ENGRAVING SCHEDULE FOR RAMP THERMOCOUPLE SELECTOR PANEL ON SHEET D73
REFERENCE DRAWINGS:

FOR THERMOCOUPLE STATION LOCATIONS SEE SHEET 041-058
FOR THERMOCOUPLE STATION DETAILS SEE SHEET 074
FOR THERMOCOUPLE RECORDER & TRANSMITTER & SELECTOR SWITCHES SEE SHEET 076

THERMOCOUPLE STATION TC-1B

THERMOCOUPLE STATION TC-3B

THERMOCOUPLE STATION TC-4B

THERMOCOUPLE STATION TC-5B

SLAB TERMINAL STATION STS(TC 2A)

SLAB TERMINAL STATION STS(TC 4B)

SLAB TEMPERATURE SIGNAL 2 POSITION SELECTOR SWITCH

SLAB TEMPERATURE SIGNAL, SEE SHEET 076

THERMOCOUPLE TRANSMITTER

POWER SUPPLY

IN

OUT

TO SLAB TEMPERATURE SIGNAL, SEE SHEET 076

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

THERMOCOUPLE CONNECTION PANEL WIRING DIAGRAM

Sheet 081
<table>
<thead>
<tr>
<th>Load Center Secondary Voltage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-V1</td>
<td>1</td>
</tr>
<tr>
<td>1A-V2</td>
<td>1</td>
</tr>
<tr>
<td>1B-V1</td>
<td>1</td>
</tr>
<tr>
<td>1B-V2</td>
<td>1</td>
</tr>
<tr>
<td>2A-V1</td>
<td>1</td>
</tr>
<tr>
<td>2A-V2</td>
<td>1</td>
</tr>
<tr>
<td>2B-V1</td>
<td>1</td>
</tr>
<tr>
<td>2B-V2</td>
<td>1</td>
</tr>
<tr>
<td>3A-V1</td>
<td>1</td>
</tr>
<tr>
<td>3A-V2</td>
<td>1</td>
</tr>
<tr>
<td>3B-V1</td>
<td>1</td>
</tr>
<tr>
<td>3B-V2</td>
<td>1</td>
</tr>
<tr>
<td>4A-V1</td>
<td>1</td>
</tr>
<tr>
<td>4A-V2</td>
<td>1</td>
</tr>
<tr>
<td>4B-V1</td>
<td>1</td>
</tr>
<tr>
<td>4B-V2</td>
<td>1</td>
</tr>
<tr>
<td>5A-V1</td>
<td>1</td>
</tr>
<tr>
<td>5A-V2</td>
<td>1</td>
</tr>
<tr>
<td>5B-V1</td>
<td>1</td>
</tr>
<tr>
<td>5B-V2</td>
<td>1</td>
</tr>
</tbody>
</table>

Phase B Voltage to Ground Transducers at Load Centers: See Sheet 027

Phase A Current Transducers at Load Centers: See Sheet 027

0-15kV 0-15kV
0-100% 0-100% Dual Scale
0-15000kW

Total Load Incoming Regulated Kilowatts Voltage Voltage

Primary Voltage

Primary Voltage

100% to be set at 13.5kV