MANUAL
for
8 lb Coffee Roaster

Installation
&
Operations

CONTENTS
1. GENERAL DESCRIPTION & EQUIPMENT ARRANGEMENT
2. LIST OF PARTS & DESCRIPTIONS
3. INSTALLATION PROCEDURES & WIRING DIAGRAMS
4. PRINCIPLES OF OPERATIONS
5. ROASTING PROCEDURES
6. DISMANTLING INSTRUCTIONS

SIVETZ COFFEE, Inc.
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th STREET
CORVALLIS, OREGON 97333 — U.S.A.
(503) 753-9713
SIVETZ COFFEE INC.
349 SW 4th Street
CORVALLIS, OREGON 97333

8 lb ROASTER - ELECTRIC WIRING

Q39585
Westinghouse
WATTS 4600
VOLTS 230

Q39585C RESTRING KIT
2 Coils, 3 Screws, 3 Nuts, 10 Washers.

SUGGESTION TO PURCHASER OF COFFEE BEAN ROASTING MACHINE:

EACH USER SHOULD HAVE ON HAND AS SPARE PARTS AT LEAST two spare heaters.

Know how to replace heaters, or have electrician/appliance repair shop that can.

NOTE: CUSTOMERS HAVE REPEATEDLY GONE INTO A PANIC WHEN THEY FIND THEY HAVE BURNED OUT A HEATER, AND HAVE NOT KEPT SPARES ON HAND. Normally one spare heater is furnished with original equipment. However, the life of these resistance heaters is a function of many variables, some of which are: voltage used, heater rating (12 or 14 ohm), frequency of roasting, amounts of stones, foreign matter falling into perforations, etc.
You now own a modern fluid bed coffee bean roasting machine. Its characteristics are such that the once thru air flow that spouts heat and mixes the beans, gives very uniform and fast heat transfer. The result is a very uniformly roasted coffee bean batch, free of tars smokey deposits, free of harsh bitey tastes, producing a well developed bean physically as well as maximizing flavor and aroma.

These positive features can only be appreciated when one compares the "baked" taste harshness and bite from cylinder roasted beans.

A very important feature of a fluid bed roaster, is our ability to measure accurately the bean temperature with an inserted thermometer. This allows for accurate degrees of roasting as well as reproducibility which cylinder roasters can not do.

All bean contact surfaces are stainless steel, and after some use the dark patina acquired in the roast chamber need not be removed.

The 10.6 Kw 25 amp 240V unit will run for many years when properly used. Batch sizes should not be less than 1 lbs nor more than 8 lbs.

When roasting manually, that is, watching bean temperature to shut off heat at desired end point, note that human mental wanderings often allow the bean temperature to go above that point desired, and that is why on other models we furnish automatic heat cutoff bean temp. controllers.

It is very important that the air flow adjustments by the voltage regulator be made so that the beans spout to the top level of chamber, and MUST NEVER STOP, otherwise beans can burn. In such an event one must have an emergency procedure to stop heating, lay chamber on metal or concrete floor, and hoe out smoking hot beans to allow to cool and to apply a hand water spray.

One can roast w/o a 1/4" mesh screen to allow chaff and dust to freely fly out, w/o losing any beans from chamber, hence the fine air blower adjustment. Great care must be taken when using the screen cover, that at near 390°F when much chaff is released, that all that chaff does not blind the screen and choke off air flow and hence cause bean movement to stop. If one chooses to use the screen at that time, the blinding chaff can be released by snapping off one corner of the screen and also blowing by mouth, during this 60 second period. A half blinded screen is OK, but a full blinded screen is not safe. Read this manual carefully before use of the roaster and before installation of wiring.
The 8 lb green coffee bean roaster system consists of a roast chamber, a voltage regulator to control blower speed and air flow (so as to control bean levitation (spouting) during the drying and pyrolysis cycles), a safety air pressure switch, that will not allow heat to come on until blower is operating, an overhead vent fan drawing air away from about the mouth of the roast chamber, and passing it through the chaff collection cyclone, and then blowing the "particle-free" air outside the building. The roast chamber heaters are composed of 3 elements each generating 3.5 Kw. They are operated on 240 volts and each element draws 15 amperes. A reset button closes electrical contactor with red-light "on" signals "heat is on."

It is up to the operator to keep sufficient air flow through the spouting beans to assure continual movement, of about 6" above bean bed. Less movement may cause beans to stop, in which case localized beans at base of cone will burn. Too much spouting wastes hot air and takes longer time to roast.

The degree of roast is controlled by continual monitoring the dial thermometer in the beans (3" insertion exactly into bean chamber). When the desired degree of roast is attained (as judged by dial thermometer reading), e.g., 450°F, the contactor causes the heat to stop, which stops heating. There may be a 3°F to 6°F override depending on beans, degree of roast, etc., but 10°F override of water spray from nozzle, after heat is cut off, will minimize over-ride of temperature, and show a positive decline in bean temperature. Continuing air flow will cool the "just" roasted beans to near room temperature.

The spouting air flow can be stopped, and the roasted beans can be scooped out of the roast chamber or be sucked out by a shop vacuum (option - not included). To preserve "just roast" aroma & flavor freshness, the "just roasted beans" must be placed in tightly sealed jars (gallon holds 3 lbs), in a freezer.

Depending on number of roasts, line voltage, abuse of equipment, etc., a heater element may fail, and this can be confirmed exactly from panel ammeter. The chamber will then have to be disconnected from its power supplies, be dismantled, and the "failed" heating element replaced. (TIME to do about 1 hour).

The operator must remain at the roaster at all times to assure of proper bean spouting. Initially green beans lose weight and a lower voltage to blowers is required to maintain 6" movement; over 400°F when beans swell to almost twice their initial volume, less air flow is required. Roast/cool time is 10/4 min.
COST BREAKDOWN ON ELECTRIC ROASTERS  9 min roasts

5 lb  8 lb  11 lb
$ 1280 pp  $ 1850 FOB  $ 2,550 FOB

Add $ 1200 for blower & cyclone
$ 2480  3,050  3,950 FOB

Add $ 1,200 for frame & assembly on frame
$ 3,680  $ 4,250  5,150

Add $ 2,000 for control panel, water spray, & ammeter
$ 5,680  $6,250  7,150 FOB
PRE ASSEMBLED Chaff Collection Cyclone & Vent Blower on Frame for use with Electric Roasters
Simple LOW COST starting Model
8 lbs Green Beans 10.5 Kw 240V

Coffee Roasting Machine ELECTRIC

3 Fixed resistance heaters.
9.125 stainless steel tube with cone.
13" x 13" x 36" high metal cabinet.(2" thick insulation).
Roasting time: 10 minutes
Bean temperature monitoring & end cutoff control MANUAL
by looking at dial thermometer-3" insertion.
ROAST BEAN UNLOADING by means of shop vacuum.

Voltage regulator controls blower speed hence air flow and
inlet air temperatures into conic bean chamber.
BEANS MUST ALWAYS BE KEPT MOVING.
HEATER PLATE 8-7/8" diameter. 16 Ga Galv.
BASE PLATE 13" x 13" with 1" lips on opposite side(2 up, 2 down).

ATTENDED ROASTER

ANYONE CAN ROAST

50 AMPERE Magnetic
contactor switch &
START-STOP push buttons

13" x 13" metal jacket
with 2" thick insulation

DIAL THERMOMETER

Blower & Air Filter
Speed controlled by
voltage regulator

BASE PLATE

3" D Perforated disc air entr.
Three heaters fixed
HEATER PLATE
air intake vent holes

AIR PRESSURE SENSOR SWITCH-SAFETY
Heaters cannot come on unless blower
is operating.

U. S. PATENT 3,964,175

SIVETZ COFFEE, Inc.
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th St
CORVALLIS, OREGON 97333 — U.S.A.
Control Panel
8 lb Roaster
General Arrangement & External Wiring for 8 lb (10½ Kw) COFFEE BEAN ROASTING MACHINES

Gourmet Coffees
Top Quality Beans, Fresh-Roasted Freshness, Clean, Rich Flavor and Aroma

ANYONE CAN ROAST BEANS
ROAST YOUR OWN COFFEE

Wall FAN

240V 8&S-50 amp

40 amp

15/20 amp

110V to H.V.

To L1, L2 & Grid

Magnetic Contactor with 220V coil

For Pressure Switch

FAN

Wall OUTLETS - Two 120V outlets

Sheet Metal Box

1/4 mesh screen

Thermocouple

SS Jacket C

2" Insulation

3 Heaters 10KW

Bean plate

Bean plate

ROAST CHAMBER - ss

Voltage Regulator

U. S. PATENT 3,964,175
Sivetz Coffee, Inc.
349 SW 4th Street
Corvallis, OR 97333

M. Sivetz
Rev 12/7 1/8
11-12-87
Rev. A 4/9 2/8
ECONOMICAL & SIMPLE
Installation & Use
of 3 and 8 lb
ELECTRIC COFFEE BEAN ROASTING MACHINES

SERVICES REQUIRED:

a) WALL FAN for room ventilation & spot light.
b) Two 120 V duplex wall outlets each on 15 or 20 ampere circuit breakers.
c) One 240 V 60 ampere circuit breakers from building panel.

d) INSTALL FAN & LIGHT.
ed) START Fan.

STEP 1 ELECTRICIAN connects 240 V power supply to
L1 & L2 & Ground from building breaker panel. Then connect...

a) 1/4" O.D. Poly tube to air pressure switch from base of roast chamber.
b) "PLUG IN" 240 V heater cord from roast chamber to panel mounted receptacle wired to control box.
c) "Plug-in" 120 V blower cord from voltage regulator into wall outlet.
d) INSERT PLUG IN coil power supply for Mag. Cont. (See Wiring Diagram).
e) Set spot light to shine into bean chamber — convert 120 V.

STEP 2 YOU ARE NOW READY TO ROAST ... about 9 minutes

a) Weigh 6.0 lbs green coffee beans. Pour beans into roast chamber. Start Fan.
b) Set in thermometer in front wall of roast chamber (2" inside chamber).
c) Place screen (1/4 mesh) over top opening of roast chamber with clamps.
d) Turn up blower voltage until beans are spouting just below top of chamber.
e) Push RESET button for heating. Red pilot light comes "ON".
f) Dial down to reduce blower speed to keep spouting beans below top (as they dry)
g) When beans reach 4500°F, via Wheaties control. Heating ends & cooling starts.
h) The roasted beans will cool down to 120°F in about 4 minutes.
i) Remove top screen after shutting off blower power.
j) Remove thermometer.
k) SCOOP out 1 1/2 cups roasted cooled beans.
l) Pour roasted beans into gallon jar, seal and place in Freezer to

PRESERVE FRESHNESS & AROMA

WARNING—
When beans reach near 380°F til about 410°F, much chaff will release.
This can BLIND the 1/4" mesh flat screen, so it must be "flicked"
to release chaff, yet not allow beans to be blown out. Failure to keep
clear impairs seeing moving beans and can cause beans to stop movin

SIVETZ COFFEE, Inc.
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th STREET
CORVALLIS, OREGON 97333 — U.S.A.
LIST of PARTS to 8 lb coffee bean roasting machine

1. ROAST CHAMBER
   a) Dimensions: 13" x 13" x 36" high, with 9.1"D ss in top with cone.
   b) ELECTRICAL CONNECTIONS:
      - 240 Volt 3 prong 50 amp. cord for 45 amp. (HTRS)
      - 120 " " 10 " for blower

2. VOLTAGE REGULATOR
   Controls speed of blower, hence air flow and pressure so that coffee beans can be levitated to peak out near top flange level. Superior Elec. Model 3PN116B rated 120V in, 140V out, 1.2 KVA with 10 amp fuse.

3. MISCL. PARTS
   a) Dial thermometer, range 50 to 500°F. Insert only 3" into chamber.
   b) 1/4" mesh screen to set on top to keep beans from flying out.
   c) Two clamps to hold screen down.
   d) Red pilot light on FURNAS to show HEAT is ON.
   e) Water spray system.
   f) Intake air filter: Inspect periodically, and change as required. A dirty air filter will reduce air flow limiting amount of beans that can be levitated, and can cause excess heating of intake air.
   g) One spare heater Q 39585

4. AUX. PARTS
   a) CHAFF COLLECTION CYCLONE: 22"D x 4'H with intake transition elbow. Inlet duct 10"D, and outlet stack 10"D (accomodates to blower intake).
   b) 5 Gallon chaff can with hoop, with 4"D inlet at top cover.
   c) Two elbows: One for turn from top of roaster, and other from Cyclone stack to blower intake.

See drawing of duct-vent arrangement.
   d) SUCTION BLOWER
      Model CG1 from N.Y. Blower with 2HP motor frame. 3600 rpm, balance 120/230V, single phase. Capacity: >1,000 CFM at 6" w.c.
      12"D wheel (steel).
   e) AUTOMATIC BEAN TEMPERATURE SENSOR (thermocouple) tied to high limit bean temp. controller (digital) which shows bean temp. and set temperature, automatic water spray, ammeter & heating time counter.

5. INSTRUCTION MANUAL

SIVETZ COFFEE CO.
349 S.W. 4th Street
Corvallis, OR 97333
(503) 753-9713
DESCRIPTION

TYPE: Single Speed, Thru-Flow, 120 Volt.

DESIGN APPLICATION: Canister-type vacuum cleaners. Equipment not requiring separation of working air from motor ventilating air. Designed to handle clean, dry, filtered air only. For additional application information write for Bulletin 2-VT570-000.

SPECIAL FEATURES:
- Component recognized by Underwriters Laboratories Inc. and Canadian Standards Association (CSA).
- Open frame construction.
- Provision for grounding.
- Double ball bearings.

All 5.7” diameter thru-flow motors feature face mounting interchangeability. The Lamb vacuum motor line offers a wide range of performance levels to meet design needs.

TYPICAL CHARACTERISTICS*
(Not to be used for setting specifications)

<table>
<thead>
<tr>
<th>@ 120 VOLTS—60 HERTZ</th>
<th>MODEL NUMBER</th>
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<tbody>
<tr>
<td>Standard Conditions:</td>
<td>115750</td>
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<tr>
<td>29.92 Inches Hg, 68°F</td>
<td></td>
</tr>
<tr>
<td>Sealed</td>
<td></td>
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<tr>
<td>Vacuum (Inches H2O)</td>
<td>92.0</td>
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<tr>
<td>Volume (CFM)</td>
<td>550</td>
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<td>Power (Watts)</td>
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<tr>
<td>Current (Amps)</td>
<td>23,500</td>
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<tr>
<td>Speed (RPM)</td>
<td></td>
</tr>
<tr>
<td>¾” Orifice</td>
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<tr>
<td>Vacuum (Inches H2O)</td>
<td>56.0</td>
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<tr>
<td>Volume (CFM)</td>
<td>61.0</td>
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<td>Power (Watts)</td>
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<td>Current (Amps)</td>
<td>7.7</td>
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<tr>
<td>Speed (RPM)</td>
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<td>1¼” Orifice</td>
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<tr>
<td>Vacuum (Inches H2O)</td>
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<tr>
<td>Volume (CFM)</td>
<td>68.0</td>
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<td>Power (Watts)</td>
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<td>Current (Amps)</td>
<td>8.0</td>
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<td>Speed (RPM)</td>
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<td>2” Orifice</td>
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<td>Vacuum (Inches H2O)</td>
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<td>Volume (CFM)</td>
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<tr>
<td>Power (Watts)</td>
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</tr>
<tr>
<td>Current (Amps)</td>
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</tr>
<tr>
<td>Speed (RPM)</td>
<td>18,500</td>
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MOTOR PERFORMANCE*

Average test data corrected to standard barometer of 29.92 in. Hg. and 68°F.

LEGEND

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<tr>
<th>Watts</th>
<th>Vacuum</th>
</tr>
</thead>
</table>

Note: Curves marked with fractional inch designations indicate air flow and vacuum through sharp-edged thin plate test orifices of diameter indicated.

*The performance data specified represents a typical or average motor. If data is required to establish acceptance specifications, contact the factory.
VOLTAGE REGULATOR for blower
120 V TO 140 V 10 amp

SIVETZ COFFEE INC.
349 SW 4th Street
CORVALLIS, OREGON 97333

(503) 753-9713
### Replacement Parts

#### Starters & Contactors

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Contacts &amp; Spring, One Complete Pole</td>
<td>75BF14</td>
</tr>
<tr>
<td></td>
<td>Power Pole Size 00</td>
<td>75CF14</td>
</tr>
<tr>
<td></td>
<td>1 Pole 75DF14</td>
<td>75EF14</td>
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<tr>
<td></td>
<td>Interlock Pole (includes spring retainer) All Sizes 75AF14</td>
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</tr>
<tr>
<td>B</td>
<td>Cross Arm (less contacts) With Cross Arm Springs 75P1000</td>
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</tr>
<tr>
<td>D</td>
<td>Contact Board Cover D29079001</td>
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<tr>
<td>K</td>
<td>Coil 50 Hertz 110v 110-120v/220-240v 190-220v 220-240v/440-480v 380-440v 550-600v/550v</td>
<td>75D73070F 75D73070A 75D73070C 75D73070E</td>
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#### Overload Relays (includes baseplate)

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<th>Part Description</th>
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<td>M</td>
<td>Melting Alloy Size 00-1 1 Pole 48DC11AA3</td>
<td>48DC11AA3</td>
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<tr>
<td></td>
<td>(std) 3 Pole 48DC31AA3</td>
<td>48DC31AA3</td>
</tr>
<tr>
<td></td>
<td>Size 1¾ 1 Pole 48EC11AA3</td>
<td>48EC11AA3</td>
</tr>
<tr>
<td></td>
<td>3 Pole 48EC31AA3</td>
<td>48EC31AA3</td>
</tr>
<tr>
<td></td>
<td>Bimetal Size 00-1 1 Pole 48DC17AA3</td>
<td>48DC17AA3</td>
</tr>
<tr>
<td></td>
<td>3 Pole 48DC37AA3</td>
<td>48DC37AA3</td>
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<tr>
<td></td>
<td>Size 1¾ 1 Pole 48EC17AA3</td>
<td>48EC17AA3</td>
</tr>
<tr>
<td></td>
<td>3 Pole 48EC37AA3</td>
<td>48EC37AA3</td>
</tr>
<tr>
<td></td>
<td>Amb Comp Size 00-1 1 Pole 48DC18AA3</td>
<td>48DC18AA3</td>
</tr>
<tr>
<td></td>
<td>3 Pole 48DC38AA3</td>
<td>48DC38AA3</td>
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<tr>
<td></td>
<td>Bimetal Size 1¾ 1 Pole 48EC18AA3</td>
<td>48EC18AA3</td>
</tr>
<tr>
<td></td>
<td>3 Pole 48EC38AA3</td>
<td>48EC38AA3</td>
</tr>
<tr>
<td></td>
<td>Melting Alloy Overload Kit — NO Contact 48ACNO</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** When ordering replacement parts, give catalog number of control and part name and number.

**Furnas Electric Company** 1000 McKee Street, Batavia, Illinois 60510
Series 1900 Pressure Switch

Installation and Operating Instructions

Set points from 0.07" to 20" W.C. Repetitive accuracy within 3%, U.L. and C.S.A. listed, F.M. approved.

Series 1910 pressure switch. All pressure and electrical connections and set point adjustments are on one side for easy installation.

Advanced design and precision construction permit these switches to perform many of the tasks of larger, costlier units. Designed for air conditioning service, they also serve many fluidics, refrigeration, oven and dryer applications. Series 1900 switches are available with set points of 0.07 to 20 inches water column. Set point adjustment can be made easily—before or after installation. Range screw is inside conduit enclosure to help prevent tampering. For easy mounting and access, pressure and electrical connections and set point adjustment are located on one side. This permits installation in corners or spaces too small for other switches.

Special Models and Accessories

(See also OEM models on page 3 of Bulletin E-50)

Dwyer Accessory Part No. A-329

Special close coupled street elbow for right angle pressure connections. Can be installed on switch anytime. Zinc plated aluminum.

Weatherproof Enclosure:

15 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5 lbs. Switch must be installed at factory. Specify "WP" in addition to switch catalog number.

Explosion-Proof Housing:

Cast iron base and aluminum dome cover. Approximate weight 2 lbs. Specify "EXPL" in addition to switch catalog number.

Physics Data

Temperature limits: 32°F (-30°F for dry air) to 180°F. Maximum surge pressure: 10 psig. Rated pressure: 45 H2O. Pressure connections: 1/4 NPT. Electrical rating: 15 amps, 120-480 volts, 60 Hz, A.C. Resin: 1/4 H.P. @ 125 volts, 250 volts. 60 Hz, A.C. See INSTALLATION for operating information above 130°F.


Model 1910 Switches: Operating Ranges and Dead Bands.

| To order Range Dead Band |
|---|---|---|
| Model Number | Operating Range, At Min. Set Point | At Max. Set Point |
| 1910-00 | 1910-10 | 1910-20 |
| 0.07 to 0.15 | 0.15 to 0.5 | 0.4 to 0.6 |
| 0.04 | 0.10 | 0.20 |
| 0.15 | 0.5 | 0.9 |
| 0.4 | 0.5 | 0.6 |

Suggested Specification

Differential pressure switches shall be diaphragm operated with 3½" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switches shall be Dwyer Instruments, Inc. Catalog No. 1910——for the required operating ranges.

Magnetic Contactor Wiring

for 81b - 104kW - 240V 45 amp Reactor with START-STOP station + pilot light

110V
Red light (HEAT 'on')

120V con

Gd

100amps Circuit Breaker
240V
Power In

SIVETZ COFFEE INC.
349 SW 4th St
CORVALLIS, OREGON 97333

81b/104kW ELECTRIC ROASTER WIRING

Actual

Schematic

R1 R2 R3

T1 T2 T3

G

3wires cond.
240V 45.0amp

Rev. 2 '91
110v 10- '88
8- '87
8.6 Electric Roaster Panel (Rear View) Wiring

12" wide x 22" high x 8" deep

240 V-20 1/2 kw
For heating
BLDG. Pwr
from 60 amp
Circuit Breaker

L1 O L2

Panel Sw

from Panel Sw

Furnas Contactors

40 HP 15 AAD4

50 amp
Resistor Heating

GRD

outside

Receptacle
for Roaster
plug

inside

RESET Button

MPB

charger

to HI Solenoid

to 1/4" OD P.E. line

1/2" OD P.E. line

WATLOW-965

WATLOW Relay

BASE-PCF-41

MK2KP-120-0.01R
Series 965

1/16 DIN Microprocessor-Based Auto-tuning Control

User's Manual

WATLOW

W965-MA10-9042
October, 1990

$10.00
Made in the U.S.A.
Use The Manual

How to Use the Manual

This manual will make your job easier. Reading it and applying the information is a good way to become familiar with the Series 965. An overview.

First...

Starting Out
Install/Wire
Front Panel
Setup
Tuning
Appendix

Notes
Safety Information
Your Feedback
Technical Assistance

WARNING: Details of a “Warning” appear here, in the narrow box on the outside of each page.

CAUTION: Details of a “Caution” appear here, in the narrow box on the outside of each page.

Technical Writer, Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987, or phone 507-454-5300. The Watlow Series 965 User’s Manual and integral software are copyrighted by Watlow Wmme, Inc. © 1990, with all rights reserved. b11090

Technical Assistance
If you encounter a problem with your Watlow Control, please send them to:

Technical Writer, Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987, or phone 507454-5300. The Watlow Series 965 User’s Manual and integral software are copyrighted by Watlow Wmme, Inc. © 1990, with all rights reserved. b11090

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WARNING: Details of a “Warning” appear here, in the narrow box on the outside of each page.

CAUTION: Details of a “Caution” appear here, in the narrow box on the outside of each page.
Chapter 1
Starting Out With The Watlow Series 965,
A Microprocessor-Based Control

General Description
Welcome to the Watlow Series 965, a 1/16 DIN microprocessor-based, single input, dual output, auto-tuning temperature control, featuring Automatic/Manual capability with bumpless transfer and a NEMA 4X rating. In the Auto mode, the 965 has closed loop control with sensory feedback, while the Manual mode has open loop control with user defined power level. The 965 accepts a Type J, K, T or N thermocouple or RTD input. The primary output is heating or cooling, while the secondary output is alarm only.

With the Series 965 you can select either PID or ON/OFF for Output 1. You may input a complete set of PID parameters, and select automatic tuning in the heating mode from the front panel for Output 1. This includes proportional band, reset/integral and rate/derivative. By setting the proportional band to zero, the Series 965 becomes a simple ON/OFF control with the switching differential selectable under the HYS Setup parameter.

Operator-friendly features include automatic LED indicators to aid in monitoring and setup, as well as a calibration offset at the front panel. The Watlow Series 965 automatically stores all information in a non-volatile memory.

Steps To Put Your Control To Work
To put your Series 965 to work, we suggest the following steps:
- Read the user's manual.
- Plan your installation and wiring.
- Cut the panel mounting hole and install the control.
- Wire your Series 965 to the system.
- Start the system and tune the Series 965.
- Make final adjustments to the control parameters and record the data.
- That's all there is to it.

Overview of the Series 965 Menus
Before getting into the details of installing and wiring the Series 965, take a look at Figure 2, and at the three different menus, “Setup,” “Operation,” and “Calibration.” After you feel comfortable with the names and their functions, move on to installation and wiring.

Configure the 965’s features to your application. Establish levels of operator access, input type, units of measure, low and high range limits, hysteresis, output, and alarm type.

Enter the set point, PID tuning values and alarm set point here. Parameters for proportional band, reset/integral and rate/derivative, and cycle time for Output 1, alarm low and high limits; calibration offset and auto-tune are here also.

Supply various input signals to the Series 965, and performs auto-calibration. Also, select either U.S. or International parameters here. Calibration procedures should only be attempted with proper equipment and by qualified personnel.

Where To Go From Here
If your Series 965 is already installed and wired, go directly to “How to Use the Keys and Displays,” Chapter 3. If not, turn the page to Chapter 2, “How to Install and Wire the Series 965,” and proceed from there.
Installation

Chapter 2

Install and Wire the Series 965

Figure 3 - Series 965 Multiple Panel Cutout Dimensions

Figure 4 - Series 965 Dimensions

Installation Procedure

Follow this procedure to mount the Wallow Series 965 Temperature Control:

1. Make a panel cutout per the dimensions in Figure 3.

2. Remove the 965 chassis from its case. Holding each side of the bezel, press firmly on the side grips until the tabs release. Pull the chassis out of the case. Put the chassis aside for later installation.

3. Make sure the rounded side of the external case gasket is facing the panel surface. Check to see that the gasket is not twisted, and is seated within the case bezel flush with the panel. Place the case in the cutout you just made. Make sure the gasket is between the panel cutout and the case bezel. See Figure 5A.

4. While pressing the front of the case firmly against the panel, slide the mounting collar over the back of the control. The tabs on the collar must line up with the mounting ridges on the case for secure installation. See Figure 5A again. Slide the collar firmly against the back of the panel getting it as tight as possible. Make sure you cannot move the case within the cutout, if you can you do not have a NEMA 4X seal.

Now, let's make sure we have a tight seal. Use your thumb to lock the tabs into place while pressing the case from side to side. Don't be afraid to apply enough pressure to install the control. The tabs on each side of the collar have teeth which latch into the ridges. See Figure 5B. Each tooth is staggered at a different height, so only one of the tabs on each side are ever locked into the ridges at any time.

Looking at Figure 6, you see that the tabs on one side of the collar correspond with those on the opposite side. Make sure that the two corresponding tabs are the only ones locked in the ridges at the same time. If the matching tabs are not holding the case at the same time you will not have a NEMA 4X seal. You can make a visual check, or use your fingernail to pull out on each tab. Only one on each side is engaged, and they must be corresponding as in Figure 6. The space between the bezel and panel must be between 0 and 0.019" (0.48 mm).

4. Insert the control chassis into its case and press the bezel to seat it. Make sure the inside gasket is also seated properly and not twisted. The hardware installation is complete. Proceed to the wiring section from here.

NOTE: To guarantee a proper NEMA 4X seal, make sure the gasket between the panel and the rim of the case is not twisted and is seated properly. PRESS FIRMLY.

4.019" (0.48 mm)

5.0 mm

Figure 5 - Mounting Case Side View & Collar Cross Section

Figure 6 - Case Rear View and NEMA 4X Seal Example

When removing the mounting collar, we suggest sliding a thin tool such as a putty knife or screwdriver under all three tabs on each side at once and pulling it back off the case.
Power Wiring

How to Wire the Series 965

The Series 965 wiring is illustrated by model number option. Check the unit sticker on the control and compare your model number to those shown here and also the model number breakdown in the Appendix of this manual.

All outputs are referenced to a de-energized state. The final wiring figure is a typical system example.

When you apply power without sensor inputs on the terminal strip, the Series 965 displays "--" or ER (reversed sensor) in the Upper display, and a "0" in the Lower display. Press the AIM key twice, and ER 7 is displayed for one second. This error indicates an open sensor or AIM error. Remove power to the control and connect the sensor properly, see Page 9. All wiring and fusing must conform to the National Electric Code and to any locally applicable codes as well.

Sensor Installation Guidelines

We suggest you mount the sensor at a location in your process or system where it reads an average temperature. Put the sensor as near as possible to the material or space you want to control. Air flow past this sensor should be moderate. The sensor should be thermally insulated from the sensor mounting.

Input Wiring

Input Option "1", Thermocouple Input
Terminals 3 & 5
Model # 965A - 1 0 0000

Input Option "2", for 2 or 3 Wire RTD
Terminals 2, 3 & 5
Model # 965A - 2 0 0000

NOTE:
Extension wire for thermocouples must be of the same alloy as the thermocouple itself to limit errors.

NOTE:
Long lead lengths create electrical resistance. There could be approximately 4.5°F/2.5°C input error for every 1 ft of lead length resistance, when using a two wire RTD. That resistance, when added to the resistance of the RTD element, can result in erroneous input to the instrument. To overcome this problem, use a three wire RTD sensor, which compensates for lead length resistance. When extension wire is used for a three wire RTD, all three extension wires must have the same electrical resistance. (i.e. same gauge, length, copper stranded.)
**Output Wiring**

**Output 1 Option "C", DC Output (Open Collector)**
Terminals 9 & 10
Model # 965A - _ C _ 0 - 0000

Switched DC
Watlow's solid state switch is a low current DC output (open collector) used to switch an external power switching device such as an SSR or an electromechanical relay. The input specifications of the power switching device must match those listed for the SS switch output. The power switching device must provide isolation between the SS switch output and load power since the SS switch output is a non-isolated output. The switched DC voltage will be between 7 and 10 VDC with a source resistance of 5000 maximum. The output is short circuit protected.

Mechanical Relay
The electromechanical relay is an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, contact closure is created through movement of the "common" contact of the relay.

**Output 1 Option "D", Mechanical Relay, Form C, 5 Amp**
Terminals 8 - 10
Model # 965A - _ D _ 0 - 0000

**Process Output**
Proportional value determined by the control to balance the sensor input and set point. This value will fall between 4-20 mA depending on your process output type. Maximum load resistance is 300Ω.

**Alarm Wiring**

**Output 2 Option "A", No Alarm Output 2**
Terminals 6 & 7
Model # 965A - _ A _ 0 - 0000

**Output 2 Option "C", DC Output (Open Collector)**
Terminals 6 & 7
Model # 965A - _ C _ 0 - 0000

**Output 2 Option "D", Mechanical Relay, Form C, 5 Amp**
Terminals 1, 6 & 7
Model # 965A - _ D _ 0 - 0000

**Process Output**
Proportional value determined by the control to balance the sensor input and set point. This value will fall between 4-20 mA depending on your process output type. Maximum load resistance is 300Ω.

**Mechanical Relay**
The electromechanical relay is an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, contact closure is created through movement of the "common" contact of the relay.

NOTE:
For more information on alarms see Page 21.
**WARNING:**
All wiring and fusing must conform to the National Electric Code NFPA70. Contact your local board for additional information. Failure to observe NEC safety guidelines could result in injury to personnel.

**CAUTION:**
Warm mercury relay loads must have a unity power factor. For RESISTIVE LOADS ONLY.

**Chapter 3**

**How to Use the Keys and Displays**

Use this page to learn the nature and function of the Series 965’s keys and displays.

**Series 965 Keys, Displays and Load LED’s**

**Upper Display**
Red, 0.3” (8 mm) high, seven segment, three digit LED display, indicating either process actual temperature, the operating parameter values, or an open sensor. When powering up, the Process display will be blank for 5 seconds.

*NOTE:*
The upper display automatically displays the process value after 1 minute without key strokes.

**Lower Display**
Red, 0.3” (8 mm) high, seven segment, three digit LED display, indicating the set point, output value, prompts for data in the upper display, or error and alarm codes.

**UP/DOWN Keys**
When pressed simultaneously for 3 seconds, the Setup Menu appears displaying the LOC parameter. Continue to press the UP/DOWN keys, and the Calibration Menu appears.

**MODE Key**
Steps the control through the Operating menu; also, in the Auto mode, new data is self entering in 5 seconds.

**AUTOMAN Key**
Pressed once, it clears any latched alarms. If pressed again within 5 seconds, the control toggles between Auto and Manual mode. While in Manual mode, percent power is in the lower display.

**UP Key**
Increases the value of the displayed parameter. A light touch increases the value by one. Holding the key down increases the value at a rapid rate. New data is soft entering in 5 seconds.

**DOWN Key**
Decreases the value of the displayed parameter. A light touch decreases the value by one. Holding the key down decreases the displayed value at a rapid rate. New data is self entering in 5 seconds.
Setup Parameters

When you are at the top of the menu, the Series 965 displays the user level of operation in the upper display, and the LOC parameter in the lower display.

When you press the MODE key, the value of the next parameter appears in the upper display, and the parameter appears in the lower display.

**Lock**: Selects the level of operator lock-out as defined below.

- **LOC 0**: All operating parameters may be viewed or changed. Manual operation is permitted. When in manual operation, percent power is adjustable.
- **LOC 1**: The set point and actual are the only visible parameters, set point is adjustable in this level. Manual operation and auto-tune are permitted. When in manual operation, percent power is adjustable.
- **LOC 2**: The set point and actual are the only visible parameters, set point is adjustable in this level. Manual operation is permitted. When in manual operation, percent power is adjustable.
- **LOC 3**: The set point and actual are the only visible parameters, set point is adjustable in this level. Manual operation is not permitted.
- **LOC 4**: The set point and actual are the only visible parameters, set point is not adjustable in this level of lock-out. Manual operation is not permitted.

**Input**: Selects the sensor input type. Only those input types which are compatible with your unit will appear. See the model number information for your type.

- **Range**: J, K (appears as H), L, N, RTD Default: J or RTD

**Celsius_ Fahrenheit**: Selects the units of temperature measurement for the control. The default is dependent on the dFL parameter located in the Calibration menu. If dFL = US, the default is F. When dFL = SI, the default is C.

- **Range**: C or F

**Range Low**: Selects the low limit of the operating range. See the model number and specification in the Appendix for range values. See Table 1 on Page 16.

- **Range**: Sensor range low to HL Default: Low limit of sensor type

**Range High**: Selects the high limit of the operating range. See the model number and specification in the Appendix for range values. See Table 1 on Page 16.

- **Range**: Sensor range high to HL Default: High limit of sensor type

**Output 1**: Selects the output action for the primary output. Action in response to the difference between set point and process variable.

- **Range**: ht, Cl. Default: ht

**Hysteresis**: Selects the switching hysteresis for Output 1 when you select o (ON/OFF) under the Pb1 parameter. See Page 17 for the Pb1 parameter.

- **Range**: 1°F ± 9°F/1°C ± 5°C Default: 3°F/2°C
Setup

Alarm Type: Determines whether the alarm is index, deviation, or none. A process alarm at an absolute temperature to prevent over/under range.

Range: Pr, dE, no Default: Pr

Latching: Selects whether the alarm is latching or non-latching. Latching alarms must be cleared before the alarm output will reset. Non-latching automatically re-codes the alarm output when the condition clears. This parameter will not appear if AL = no.

Range: LA or nLA Default: nLA

Silencing: Selects alarm silencing (inhibit) for the alarm. This parameter appears only when AL = dE. For more information see Chapter 5, “Using Alarms.”

Range: On or OFF Default: OFF

RTD: Selects the RTD calibration curve for RTD inputs. This parameter will not appear unless In = rd. JIS = 0.003916°F/°C, DIN = 0.00385°F/°C.

Range: din or JIS Default: din

Setup Menu

Use this page as a master copy for configuring your Series 965. Do not enter any values here; make photocopies instead.

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Sensor Range Low</th>
<th>Sensor Range High</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>32°F/0°C</td>
<td>99°F/55°C</td>
</tr>
<tr>
<td>K (appears as H)</td>
<td>99°F/33°C</td>
<td>99°F/55°C</td>
</tr>
<tr>
<td>L</td>
<td>5°F/1°C</td>
<td>32°F/0°C</td>
</tr>
<tr>
<td>N</td>
<td>32°F/0°C</td>
<td>99°F/55°C</td>
</tr>
<tr>
<td>Rd (1)</td>
<td>-200°F/-30°C</td>
<td>1,000°F/55°C</td>
</tr>
</tbody>
</table>

Table 1: Input Ranges.

Table 2: Setup Menu

Operation

NOTE: The upper display will always return to the process value after 1 minute without key strokes.

Operation Parameters

Set Point: Sets the operating set point for Output 1. Represents the process value the system tries to achieve for Output 1. "SP" does not appear, the control set point value will.

Proportional Band 1: A proportional band expressed in degrees, within which a controller proportioning function is active for Output 1. When Pb1 = 0, the unit functions as an ON/OFF control. The switching differential is then determined by the HYS parameter.

Range: 0 to 99°F/55°C Default: 25°F/14°C

Reset 1: A reset (integral) control action for Output 1 that automatically eliminates offset, or "droop," between set point and actual process temperature in a proportional control. This parameter will not appear if Pb1 = 0 or dFL = SI.

Range: 0.00 to 9.999 repeats/minute Default: 0.00

Integral Time 1: An integral control action for Output 1 that automatically eliminates offset, or "droop," between set point and actual process temperature in a proportional control. Entering 0.00 disables integral. This parameter will not appear if Pb1 = 0 or dFL = SI.

Range: 0.00 to 99.9 minutes/repeat Default: 0.00

Rate 1: The rate (derivative) function for Output 1 of the Series 965. The rate is determined by how fast the error is changing. This parameter will not appear if Pb1 = 0 or dFL = SI.

Range: 0.00 to 99.9 minutes Default: 0.00

Derivative 1: The derivative function for Output 1 of the Series 965. The derivative is determined by how fast the error is changing. This parameter will not appear if Pb1 = 0 or dFL = SI.

Range: 0.00 to 99.9 minutes Default: 0.00

Setup, Chapter 4
Chapter 5

How to Tune and Operate

Tuning - Automatic

Auto-tuning: The Series 965 can automatically tune the PID parameters to fit the characteristics of your particular thermal system.

The auto-tuning procedure operates on a thermal response value — slow, medium, or fast. Use the slow thermal response when your process does not need to reach set point too rapidly, or if it usually does not often exceed set point. A fast thermal response produces a rapid temperature change over a short period of time.

You can only auto-tune when Output 1 is heat. Once the auto-tune sequence has begun, the lower display flashes between At and the set point. Once the auto-tune sequence has begun, the lower display flashes between At and the set point. Once the auto-tune sequence has begun, the lower display flashes between At and the set point. Once the auto-tune sequence has begun, the lower display flashes between At and the set point. Once the auto-tune sequence has begun, the lower display flashes between At and the set point. Once the auto-tune sequence has begun, the lower display flashes between At and the set point.

Once the control finishes "learning" the system, it returns to a standard PID control with the heat PID values automatically set as a result of the auto-tuning. Tuning is complete within 60 minutes. Any change of the set point, while in auto-tune, re-initiates the auto-tune procedure.

To start auto-tuning:

1. Press the MODE key until the AUI prompt appears in the data display.
2. Select a thermal response value, 1=slow, 2=medium, and 3=fast, using the UP/DOWN keys. A thermal response value of 2 satisfactorily tunes most thermal systems.
3. Press the MODE key. While the control is in the tuning mode, the lower display alternately displays the normal information and the prompt At. The time between alternations is 1 second.
4. When tuning is complete, the displays return to their previous state and AUI reverts to 0. The 965 installs appropriate PID tuning parameters and saves them in the non-volatile memory.

To abort auto-tuning, operator must reset the AUI parameter to 0, or press the AUTO/MAN key twice. The auto-tuning process may also be aborted by cycling the power off and on. In all cases, aborting auto-tune restores all original values.
Tuning - Manual

For optimum control performance, tune the Series 965 to the thermal system. The tuning settings here are for a broad spectrum of applications; your system may have somewhat different requirements. **NOTE:** This is a slow procedure, taking from minutes to hours to obtain optimum value.

1. **Apply power to the Series 965** and enter a set point. Begin with these Operation Parameters: \( PB1 = 1 \), \( I = 0.00 \), \( RA1/DE1 = 0.00 \), \( C = 5 \), CAL = 0

2. **Proportional Band Adjustment:** Gradually increase \( PB1 \) until the upper display temperature stabilizes to a constant value. The process temperature will not be quite on set point because the initial reset value is 0.00 repeat per minute. **(When \( PB1 = 0 \); \( RA1/DE1 \) and \( I \) are inoperative, and the 965 functions as a simple ON/OFF control.)** The HYS parameter determines the switching differential value.

3. **Reset/Integral Adjustment:** Gradually increase \( R \) or decrease \( I \) until the upper display temperature begins to oscillate or “hunt.” Then slowly decrease \( R \) or increase \( I \) until the upper display stabilizes again near set point.

4. **Cycle Time Adjustment:** Set \( Ct1 \) as required. Faster cycle times sometimes achieve the best system control. However, if a mechanical contactor or solenoid is switching power to the load, a longer cycle time may be desirable to minimize wear on the mechanical components. Experiment until the cycle time is consistent with the quality of control you want.

5. **Rate/Derivative Adjustment:** Increase \( RA1/DE1 \) to 1.00 minute. Then raise set point by 20° to 30°F, or 11° to 17°C. Observe the system’s approach to set point. If the load temperature overshoots set point, increase \( RA1/DE1 \) to 2.00 minutes.

6. **Calibration Offset Adjustment:** You may want your system to control to a temperature other than the value coming from the input sensor. If so, measure the difference between that temperature (perhaps at another point in the system) and the process value showing in the upper display. Then enter the CAL offset value you want. Calibration offset adds or subtracts degrees from the value of the input signal.

**Manual and Automatic Operation**

To change from manual to automatic operation, press the AUTO/MAN key twice.

Manual operation provides direct (time proportioned % power) control of the output from -100% to 100%. The 965 allows a negative output value only with a C (Cool) selection on \( C \). A positive output value is allowed with heat only.

Automatic operation provides closed loop ON/OFF or PID control. When the operation transfers from a closed loop to an open loop, the 965 retains the power level from the closed loop control, it restores the previous set point temperature.

The MAN LED indicates auto or manual operation. When the LED is ON, the control is in Manual operation. When the LED is OFF, the control is in AUTO operation. When the LED flashes, press the key again within five seconds to complete the change in operation. If the sensor is open and \( LOC = 0 \), or 2, the Series 965 switches to Manual operation (time proportioned % power); if the output was stable before the break occurred.

When transferring from auto to manual operation, the control output(s) remain stable (“bumpless,” smooth transition). When transferring from manual to automatic operation, the control output(s) may change significantly. In manual, the output value (% power) appears in the lower display. In automatic operation, the set point appears.

**Using Alarms**

The Series 965 has two alarm types, Process or Deviation. A Process alarm sets an absolute temperature when the process exceeds that absolute temperature limit. Process alarm set points may be independently set high and low.

A Deviation alarm alerts the operator when the process stays too far from set point. The operator can enter independent high and low alarm settings. The reference for the deviation alarm is the set point. Any change in set point causes a corresponding shift in the deviation alarm. Example: If your set point is 10°F/55°C, and you have a deviation alarm set at +2°F/1°C as the high limit, and 5°F/2°C as the low limit, the high alarm trips at 107°F/41.6°C, and the low alarm at 95°F/36°C. If you change the set point to 130°F/55°C, the alarms follow the set point and trip at 132°F/59°C and 125°F/51.6°C.

**Alarm Silencing**

Silencing is available with the deviation alarm. When \( SIL \) is selected as “on,” the non-latching mode automatically enables the alarm out put on initial power-up. In the latching mode, the operator must manually disable the alarm by pressing the AUTO/MAN key once. **CAUTION:** An alarm in error condition or when the control is in the Calibration or Setup Menu is invalid.

**Both Process and Deviation alarms can be latching or non-latching.** The operator must manually reset a latching alarm before the alarm will reset. The operator must also remove the condition that created the alarm. If the operator removes the condition causing the alarm, a non-latching alarm automatically resets the alarm output.

Flashing “LO” or “HI” in the lower display indicates an alarm. The lower display alternately shows information from the current parameter and the “LO” or “HI” alarm message at one second intervals. The alarm output is de-energized and the AL LED is lit.

To clear an alarm...

- First correct the alarm condition, then...
  - If the alarm is latching...
    Clear it manually; press the AUTO/MAN key once as soon as the process temperature is inside the alarm limit by 1°F/0.6°C.
  - If the alarm is non-latching...
    The alarm clears itself automatically as soon as the process temperature is inside the alarm limit by 1°F/0.6°C.
Error Codes

**How To Deal With Error Codes**

Three dashes, "--" or "rES" (reversed sensor), in the upper display indicate a Series 965 error.

- If operator access is LOC 0, 1 or 2...
  - Press the AUTO/MAN key twice to see the error code for one second.
- If operator access is LOC 3 or 4...
  - The error code is already in the lower display.
- Error code definitions and actions...

**Er 1 - Sensor overrange error**
The sensor input generated a value higher than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is above the range limits, but within the A/D conversion limits. Make sure the In parameter matches your sensor.

**Er 2 - Sensor underrange error**
The sensor input generated a value lower than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is below the range limits, but within the A/D conversion limits. Make sure the In parameter matches your sensor.

**Er 3 - Ambient error**
Check the specification for the ambient temperature range.

**Er 4 - Configuration error**
The unit's microprocessor is faulty; call the factory.

**Er 5 - Non volatile checksum error**
The nonvolatile memory checksum discovered a checksum error. Unless a momentary power interruption occurred while the unit was storing data, the nonvolatile memory is bad. Call the factory.

**Er 6 - A/D underrange error**
The A/D circuit is underrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good and functions properly, call the factory. The A/D underrange voltage is too low to convert an A/D signal. Make sure the In parameter matches your sensor.

**Er 7 - A/D overflow error**
The A/D circuit is overrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good and the sensor functions properly, call the factory. The A/D overrange voltage is too high to convert an A/D signal. Make sure the In parameter matches your sensor.

- To clear a corrected error...
  - Cycle power to the control.

---

**Errors/Outputs**

**Er 1, 2, 3, 6 & 7 Errors - Control Outputs May Be ON**

- If operator access is LOC 0, 1 or 2...
  - The control was in AUTO operation when the error occurred. The control was in MANUAL (%) power operation. If the output power is less than 75% power, and a <5% change in power occurred within the last two minutes, the 965 switches into Manual operation at the last Automatic power level. If the control was in MANUAL operation, it remains there. (You must press the AUTO/MAN key twice to see the error code.) The alarm output (if present) is in its alarm state (LED lit). The upper display reads "--" or rES. The lower display indicates the error code.

- If the control was operating with stable output values when the error occurred, it continues to operate at those levels on a % power basis. If output values were not stable, the control outputs go to 0% power (OFF)

**Er 4 & 5 Errors - Control Outputs Will Be OFF**

- Error codes Er 4 and Er 5 result in these conditions:
  - The control is in AUTO operation with the output OFF.
  - The alarm output, if present, is in the alarm state (de-energized with the LED lit).
  - The upper display indicates the process value.
  - The lower display indicates the error code.
  - All keys are inactive.
  - All Setup menu parameters return to default values.
  - The above conditions occur regardless of the value of LOC, or the presence of the Setup or Calibration Menus.

- To clear a corrected error...
  - Cycle power to the control.
Specifications

Appendix 1

Control Mode
- Microprocessor-based, user selectable control modes.
- Single input, single control output.
- Single alarm option.
- Control output: User selectable as: Heat, Cool.
- ON/OFF: Switching differential determined by the HYS parameter for Output 1.
- PID parameters:
  - Proportional band: 0 to 999°F/0 to 555°C.
  - Integral: 0.00 to 99.9 minutes per repeat.
  - Rate/Derivative: 0.00 to 9.99 minutes.
- Alarm output: User selectable as:

Operator Interface
- Membrane front panel.
- Dual, three digit 0.3" (8 mm) LED displays.
- MODE, AUTO/MANUAL, UP, and DOWN keys.

Input
- Thermocouple or RTD input.
- Automatic cold junction compensation for thermocouple.
- RTD input 2 or 3 wire, platinum, 100 ohm at 0°C software selectable.
- Selectable sensor break protection de-energizes control outputs to protect system.
- Grounded or ungrounded sensors.
- °F or °C display, user selectable.
- Operating ranges user selectable.
  - J\(^\circ\)C: 32 to 999°F or 0 to 750°C
  - K\(^\circ\)C: -99 to 999°F or -99 to 999°C
  - T\(^\circ\)C: -99 to 662°F or -99 to 350°C
  - N\(^\circ\)C: 32 to 999°F or 0 to 999°C
  - 1st RTD: -99 to 999°F or -99 to 600°C

Primary Output (Heating or Cooling)
- Electromechanical relay, Form C, 5A @ 250VAC maximum, rated resistive load, 5A @ 30VDC.
- Switched DC (Open Collector), 5000 minimum load resistance, 1KΩ load, 7mA minimum, 10mA maximum, non-isolated, short circuit protected.
- 4-20mA reverse or direct acting into a 300Ω maximum load Impedance, non-isolated.

Alarm
- Electromechanical relay, Form C, 5A @ 250VAC maximum, rated resistive load, 5A @ 30VDC.
- Switched DC (Open Collector), 5000 minimum load resistance, 1KΩ load, 7mA minimum, 10mA maximum, non-isolated, short circuit protected.
- Latching or non-latching.
- Process or deviation.

Accuracy
- Calibration Accuracy and Sensor Conformity: ± 0.1% of span, ± 1 LSD.
- 7°F ± 5°F (25°C ±3°C) ambient & rated line voltage ± 10%.
- Accuracy Span: 100°F or 54°C minimum.
- Temperature Stability: 0.2°F/°F (0.2°C/°C) change in ambient.
- Voltage Stability: ± 0.01% of span / % of rated line voltage.

Agency Approvals
- UL, CSA pending.
- NEMA 4X rating pending.

Terminals
- #6 compression type screw terminals.

Power
- 85 - 264 VAC, 50/60Hz ±5%.
- 9VA maximum.
- Data retention upon power failure via nonvolatile memory.

Operating Environment
- 32 to 149°F or 0 to 65°C.
- 0 to 90% RH, non-condensing.

Dimensions
- Height: 2.1 in
- Width: 2.1 in
- Overall depth: 4.7 in
- Behind panel depth: 4.1 in
- Weight: 0.2 lb max.

Model No.

Series 965 Model Number Information
The Series 965 Model Number, listed on your unit sticker, is defined below.

Control Series
965 = 1/16 DIN, single input and output, single alarm, dual digital displays.

Input Type
1 = Type J, K, T, N thermocouple
2 = RTD 1°

Control Output
C = Switched DC (Open Collector), non-isolated
D = Mechanical Relay, Form C, 5A
F = Process 4-20mA, non-isolated

Alarm Output
A = None
C = Switched DC (Open Collector)
D = Mechanical Relay, Form C, 5A

Accessories
- Mounting Collar 0822-0395-0000
- Case Gasket 0830-0402-0002
- Internal Gasket 0830-0402-0001
Appendix 2

Noise and Installation Guidelines

Installation Guidelines For Preventing Noise

For improved electrical noise immunity, install the Series 965 as far away as possible from motors, relays, and other similar electrical noise generators.

Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference which may result in error codes in the Series 965.

The Culprit

Most noise problems stem from inadequate wiring practices. They're the major means of coupling noise from its sources to the control circuit. The following information will tell you how to eliminate or decrease noise.

An Information Resource


Noise Sources

- Switches and relay contacts operating inductive loads such as motors, coils, solenoids, and relays, etc.
- Thyristors or other semiconductor devices which are not zero crossover-fired (randomly-fired or phase angle-fired devices).
- All welding machinery.
- Heavy current carrying conductors.
- Fluorescent and neon lights.

How To Decrease Noise Sensitivity

- Physical separation and wire routing must be given careful consideration in planning the layout of the system. For example, A.C. power supply lines should be bundled together and physically kept separate from input signal lines (sensor lines). A 12" (305 mm) minimum separation is usually effective. Keep all switched output signal lines (high power level) separated from input signal lines (sensor lines). Cross other wiring at 90° angles whenever crossing lines is unavoidable.
- Another important practice is to look at the system layout; identify and locate electrical noise sources such as solenoids, relay contacts, motors, etc. Route the wire bundles and cables as far away as possible from these noise sources. Don't mount relays or switching devices close to a microprocessor control. Don't have phase angle-fired devices in the same electrical enclosure or on the same power line with the control.
- Shielded cables should be used for all low power signal lines to protect against magnetic and electrostatic coupling of noise. Some simple pointers are:
  - Whenever possible, run low level signal lines unbroken from signal source to the control circuit.
  - Connect the shield to the control circuit at both ends of signal lines. Never connect both shield ends to a common or ground.
  - Assume no electrostatic shielding when using the shield as a signal return. If you must do this, use trialed cable (electrostatically shielded coaxial cable).
- Use twisted pair wire any time control circuit signals must travel over two feet, or when you bundle them parallel with other wires.
- The size or gauge of wire should be selected by calculating the maximum circuit current and choosing the gauge meeting that requirement. Using larger wire sizes than required generally will increase the likelihood of electrostatic (capacitance) coupling of noise.
- Do not daisy chain A.C. power (or return) lines, or output signal (or return) lines to multiple control circuits. Use a direct line from the power source to each input requiring A.C. power. Avoid paralleling L1 (power lead) and L2 (return lead) to load power solenoids, contactors, and control circuits. If an application uses L1 (power lead) to switch a load, L2 (return lead) has the same switched signal and could couple unwanted noise into a control circuit.
- Grounding the chassis of each piece of equipment in the system is very important. Here is a simple practice that works best: 1) Connect each individual equipment to the over-all chassis immediately adjacent to that piece. 2) Tie all the major chassis ground terminals together with one lead (usually green wire) tied to ground at one point. Don't connect ground to the control case if the control is in a grounded enclosure (preventing ground loops).

How To Eliminate Noise

- Use "snubbers" ("QUENCHARC™") to filter out noise generated by devices such as relays, relay contacts, solenoids, motors, etc. A snubber is a simple filter device using a 0.1µF, 600 volt, non-polarized capacitor in series with a 10 ohm, 1/2 watt resistor. The device can be used on A.C. or D.C. circuits to effectively dampen noise at its source.
- The ultimate protection is an "uninterruptable" power supply. This "senses" the A.C. power line; when the line fluctuates, a battery powered 50Hz inverted circuit takes over, supplying power within one half to one cycle of the A.C. line; very expensive.
Appendix 3

Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

Calibration Menu

In the Calibration Menu, various input signals must be supplied in order for the control to go through its auto calibration. The calibration menu can only be entered from the LOC parameter in the Setup Menu. Press the UP/DOWN keys simultaneously for 3 seconds (± 1 second). The CAL parameter appears entered from the LOC parameter in the Setup menu. Press the UP/DOWN keys to change the upper display to "YES." Press the AUTO/MAN key to enter the calibration sequence. After warm-up put the unit in the CAL menu. See Figure 23 on Page 26.

Any inadvertent change in the displayed data, when pressing the UP/DOWN keys, is ignored. Calibration values won't be retained unless you are in the MANUAL mode. Press the UP/DOWN key to change the upper display to "YES." Press the MODE key to enter the calibration sequence.

Upon entering the calibration menu, the top display window indicates CAL. The upper display continues to indicate CAL (with the exception of calibration of the 4-20mA output) while the operator walks through the entire calibration parameter list. While calibrating the 4-20mA output, the upper display contains a numeric value to be skewed up or down until the output value is correct. The control uses the lower display to prompt the user as to what the input should be. The RS parameter restores the factory calibration values to the Series 965. If you calibrate your control incorrectly, you have the option to default to the original values. Once you leave the CAL menu, the values are entered.

The dFL parameter allows you to select either U.S. parameters which include displaying rate, reset, and °F, or you can select SI (System International). The parameters displayed here are integral, derivative, and °C.

The following is a list of calibration parameter and parameter values. The parameters displayed here are integral, derivative, and °C.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL 1</td>
<td>YES to calibrate. No skips to display test.</td>
</tr>
<tr>
<td>CAL 2</td>
<td>Enter 0.00mV for 4mA or 59.981 for RTD.</td>
</tr>
<tr>
<td>CAL 3</td>
<td>Enter 40.00mV for 20mA or 117.330 for RTD.</td>
</tr>
<tr>
<td>CAL 4</td>
<td>Hook up &quot;J&quot; Thermocouple Calibrator.</td>
</tr>
<tr>
<td>CAL 5</td>
<td>Enter 4-20mA output calibration value for 4mA.</td>
</tr>
<tr>
<td>CAL 6</td>
<td>Enter 4-20mA output calibration value for 20mA.</td>
</tr>
<tr>
<td>CAL 7</td>
<td>Restore factory calibration values.</td>
</tr>
<tr>
<td>CAL 8</td>
<td>Displays system only.</td>
</tr>
<tr>
<td>CAL 9</td>
<td>Select US (rate, reset, °F) or SI (integral, derivative, °C).</td>
</tr>
<tr>
<td>CAL 10</td>
<td>Factory use only.</td>
</tr>
<tr>
<td>CAL 11</td>
<td>Factory use only.</td>
</tr>
<tr>
<td>CAL 12</td>
<td>Factory use only.</td>
</tr>
<tr>
<td>CAL 13</td>
<td>Factory use only.</td>
</tr>
</tbody>
</table>

Thermocouple Field Calibration Procedure

Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

Equipment Required

1. Type "J" Thermocouple Calibrator set at 32°F/0°C.
2. Precision millivolt source, 0-40mV min. range, 0.01mV resolution.
3. Hook up "J" Thermocouple Calibrator set at 32°F/0°C.
4. Connect a Thermocouple Lead to the 965 terminal strip.
5. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the CAL prompt, enter 0.00mV from the millivolt source to the control.
7. At the AUTO/MAN prompt, enter 40.00mV from the millivolt source to the control.
8. Press the AUTO/MAN key twice to enter the MANUAL mode.
9. Connect the AC line to the 965 terminal strip.
10. Allow at least 10 seconds to stabilize. Press the MODE key.

NOTE: Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Tables, Pages 15 and 16.

IMPORTANT:

Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.
**RTD Calibration**

### RTD Field Calibration Procedure

Before attempting any calibration procedure, make sure you have the proper equipment called for in each procedure.

**Equipment Required**
- 1KΩ precision decade resistance box with 0.01 ohms resolution.

### Setup And Calibration

**NOTE**
Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 16 and 18.

1. Connect the AC line voltage L1 and L2 to the proper terminals of the 965. See Chapter 2.
2. Connect the decade resistance box to Terminal #2, 3 and 5 on the terminal strip. Use regular 20 - 24 gauge wire of the same length and type.
3. Apply power to the unit and allow it to warm up for 15 minutes. After warm-up, put the unit in the CAL menu. See Figure 23 on Page 28. Press the MODE key until the CLO prompt is displayed.

**IMPORTANT:**
When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTOMAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in MANUAL mode only when you are in the correct parameters.
5. At the CLO prompt, set the decade resistance box to 59.59. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the CM prompt, set the decade resistance box to 317.33. Allow at least 10 seconds to stabilize. Press the MODE key.

### 4-20mA Output Field Calibration Procedure

Before attempting any calibration procedure, make sure you have the proper equipment called for in each procedure.

**Equipment Required**
- 500Ω, 1/2 watt 1% resistor.
- 4 - 1/2 digit Digital Multimeter.

**Setup And Calibration**

**NOTE**
Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 16 and 18.

1. Connect the AC line voltage L1 and L2 to the proper terminals of the 965. See Chapter 2.
2. Connect the multimeter in series with the 500Ω resistor to Terminal #9 Positive and #10 Negative on the Series 965 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. After warm-up, put the unit in the CAL menu. Press the MODE key until the 4AO prompt is displayed.

**IMPORTANT:**
When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the 4M key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.
5. At the 4AO prompt, the multimeter should read approximately 4mA. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 3.85mA ± 0.10mA. Press the MODE key.
7. At the 2AO prompt, the multimeter should read approximately 20mA. Allow at least 10 seconds to stabilize. The unit will leave the CAL mode if 1 minute passes between key activations except for 4-20mA units.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 20.15mA ± 0.10mA.
9. To conclude the 4-20mA output calibration, advance the MODE key to the next prompt or exit the CAL menu.
Glossary, A-O

This glossary includes general thermal system control terms.

Alarm: A condition, generated by a controller, indicating that the process has exceeded or fallen below the set or limit point.

Alarm Silence: Disables the alarm relay output on power up.

Anti-reset: Control feature that inhibits automatic reset action outside the proportional band.

Automatic prompts: Data entry points where a microprocessor-based control "prompts" or asks the operator/programmer for information input.

Auto-tune: Automatically tunes the Series 965 PID parameters to fit the characteristics of your particular thermal system.

Bumpless transfer: When transferring from auto to manual operation, the control output(s) will not change ("bumpless," smooth transition).

Closed loop: Control system that has a sensing device for process variable feedback.

Cold junction: Point of connection between thermocouple metals and the electronic instrument.

Cold junction compensation: Electronic means to compensate for the effective temperature at the cold junction.

Cycle time: The time necessary to complete a full on-through-off period in a time proportional control system.

Derivative: Anticipatory action that senses the rate of change of the process, and compensates to minimize overshoot and undershoot. Also "rate."

Deviation alarm: An alarm referenced at a fixed number of degrees, plus or minus, from set point.

Default parameters: The parameters, or programmed instructions, permanently stored in microprocessor software to provide a data base.

DIN: Deutsche Industrial Norms, a widely-recognized German standard for engineering units.

Display capability: In a digital indicating instrument, the entire possible span of a particular parameter or value.

Drop: Difference in temperature between set point and stabilized process temperature.

Duty cycle: Percentage of "on" on time relative to total cycle time.

Hysteresis: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Hunting: Oscillation or fluctuation of process temperature between set point and process variable.

Input (sensor): Process variable information being supplied to the instrument.

Integral: Control action that automatically eliminates offset, or "droop," between set point and actual process temperature. Also "reset."

Isolation: Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS: Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

NEMA 4X: Intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and sand, splashing water, and hose-directed water.

Offset: Adjustment to actual input temperature and to the temperature values the Series 965 uses for display and control.

ON/OFF control: Control of temperature about a set point by turning the output full on below set point and full off above set point in the heat mode.

Open loop: Control system with no sensory feedback.

Output: Action in response to difference between set point and process variable.

Overshoot: Condition where temperature exceeds setpoint due to initial power up or process changes.

P control: Proportioning control.

Parameter: A physical property whose value determines the response of an electronic control to given inputs.

PD control: Proportioning control with rate action.

PID control: Proportioning control with auto-reset and rate.

Process variable: Thermal system element to be regulated, such as time, temperature, relative humidity, etc.

Programmed display data: Displayed information which gives the operator/programmer the programmed or intended process information, i.e., intended set point, intended alarm limit, etc. See "Actual displayed data."

Proportional band: Span of temperature about the set point where temperature proportional control action takes place.

Proportional control: See Time Proportioning Control.

Rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also "derivative."

Rate Band: A thermal control band that defines where the rate (derivative) function begins. A WATLOW rate band occurs centered on set point at one or more times the width of the proportional band.

Reference junction: Synonymous with cold junction. See "Cold junction."

Reset: Control action that automatically eliminates offset, or "droop," between set point and actual process temperature. Also "integral."

Reset windup inhibit: Synonymous with anti-reset. See "Anti-reset."

Glossary, P-Z

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

Set point: Intended value of the process variable.

Switching sensitivity: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Thermal system: A regulated environment consisting of a heat source, heat transfer medium, sensing device and a process variable control instrument.

Thermocouple: Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

Thermocouple break protection: Fail-safe operation that assures output shutdown upon an open thermocouple condition.

Three mode control: Proportioning control with reset and rate.

Time Proportioning Control: Action which varies the amount of ON and OFF time when "close" to the set point, i.e., in the proportional band. This variance is proportional to the difference between the set point and the actual process temperature in other words, the amount of time the output relay is energized depends on the system temperature.

Trac: Solid state switching device.

Upper display data: Displayed information which gives the operator/programmer real or actual data, i.e., actual process temperature. See "Programmed display data."

Warm Start: Start-up condition where all program information is remembered by the instrument's memory back-up protection.

Zero switching: Action that provides output switching only at the zero voltage crossing points of the AC line.
Appendix, 21
Alarms, 21
Bumpless transfer, 21
Calibration, 21
Auto-tuning, 19
Automatic Operation, 13, 20
AUTO/MAN key, 13
DOWN Displays, 13
DC Alarm output, 11
DC Output 1, 10
Dimensions, 10
Dimensions, Faceplate 6, Panel Cutout, 6
Sensitivity, 10
Sensitivity, 10
How To Eliminate, 27
Sensitivity, How To Decrease, 26
Operating Menu and Default Parameters, 18
Operation Parameters, 17
Output Wiring, 17
SA Mechanical Relay, 10
4-20mA, 10
DC (Open Collector), 10
None used, 11
DC Duplex, 11
5A Mechanical Relay, 11
Overview of the Series 965, 5
Panel Cutout, 6
Power Wiring, 8
Preventing Noise, Installation Guidelines, 25
Process Output, 16
Q, R
Reattributes, 35
RTD Calibration, 30
RTD Sensor Wiring, 9
S
Sensor Wiring, 9
Series 965 Input And Output Overview, 4
Setup Chart, 16
Setup Menu and Parameters, 14
Specifications, 24
Steps To Put Your Control To Work, 5
System, Planning, 6
Wiring Example, 12
T
Thermocouple Calibration, 26
Thermocouple Sensor Wiring, 9
Tuning, 19
U, V, W
UP/DOWN keys, 13
Upper Display, 13
Warranty, 35

Warranty
The Watlow Series 965 is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow’s obligations hereunder, at Watlow’s option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

Returns
1. Call Wallow Customer Service, 507/454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. You need this information:
   - Ship to address
   - Bill to address
   - Contact name
   - Phone number
   - Ship via
   - Your P.O. number
   - Symptoms and/or special instructions
   - Name and phone number of person returning the material.
2. Prior approval and an RMA number, from the Customer Service Department, is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork. Return on a freight prepaid basis.
3. After we receive your return, we will examine it and determine the cause for your action.
4. In cases of manufacturing defect, we will enter a repair order, replacement order, or issue credit for material. A 20 percent restocking charge is applied for all returned stock controls and accessories.
5. If the unit is unrepairable, it will be returned to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

Watlow Controls
Watlow Controls is a division of Watlow Electric Mfg. Co., St. Louis, MO, a manufacturer of industrial electric heating products, since 1922. Watlow begins with a full set of specifications and completes an industrial product that is manufactured totally in-house, in the U.S.A. Watlow Controls include electric heaters, sensors, controls and switching devices. The Winona operation has been designing solid-state electronic control devices since 1962, and has earned the reputation as an excellent supplier to original equipment manufacturers. These OEMs depend upon Watlow Controls to provide compatibility engineered controls which they can incorporate into their products with confidence. Watlow Controls resides in a 100,000 square foot marketing, engineering and manufacturing facility in Winona, Minnesota.
The coffee bean roasting process is graphically depicted on the accompanying Bean Temperature vs Flavor level chart. Final bean temperature can only be accurately measured in a fluid bed type roaster, not in a cylinder. Palatable roasts lie between 440°F & 480°F which limits are "light" and Italian, whereas the best flavored roasts lie between 450°F & 460°F which can be called "European". There are culturally sought roasts, like Arabic which can be as light as 415°F, or burnt up to 490°F. The eye can only crudely judge degree of roast, and is not always accurate nor reproducible.

Most commercial coffees used in the USA are near 12 wt% moisture, and roast weight losses can vary from 14 wt% to 20+ wt%, 25 wt% when burnt. Decaf coffees usually have about 8 wt% moisture, vs 12 wt% for naturals. Some times Colombian beans have 14 wt% moisture, as do new crop in some growing country situations, e.g. KONA.

A well roasted bean is brown from its outer edge to inner core. A uniformly roasted batch of beans is uniform in color when of good quality. Poor quality beans or non-uniform beans give non uniform roast bean colors.

Roasting processes... are characterized by heating up the beans and driving off the moisture. Initially released water is called free water. When bean temperatures reach 340°F, bound water is slowly released. At near 400°F, and slightly higher, the 2 to 4 wt% sucrose within the bean begins to caramelize, turn brownish and darker with increased temperatures. Water and carbon dioxide from sugar decomposition, is released with increasing amounts of aldehydes, ketones, esters, sulfides (from protein), etc. that give the characteristic coffee aromas between 430°F and 450°F. At higher temperatures, the aldehydes/ketones diminish and more acrid aromatics predominate. Light roasts have more acids than dark roasts. The bean temperature attained is closely related to bean color and taste. At about 420°F pyrolysis occurs, which is the decomposition of sugars caramelization and release of heat (exothermic reactions). Hence, once beans are heated to the pyrolysis point, the beans themselves give up heat. As roasts get darker, it is often essential to use a small amount of water spray to stop the pyrolysis hence control degree of roast. At over 400°F no water is absorbed by the roasting beans, as some people unwittingly claim. During pyrolysis the beans swell to almost twice their green volume, and this is accompanied by "popping" sounds, which is very normal to good beans. Higher grown denser beans like Sumatra require about a 5°F higher treatment. Much chaff is released from the swelling beans at near 400°F.
PRINCIPLES of Roaster Operations

The principle of roasting coffee beans is by using a hot air blast up a perforated opening at the base of a cone. This causes the coffee beans (or grain) to spout up at the center, simultaneously being heated and cleaned. The beans resting in the chamber slide down the cone to be relifted, thereby effecting good circulation for uniform heating.

It is important to keep the beans moving ALWAYS; stationary beans will overheat and possibly burn. Therefore, the operator or attendant must be present during the 8 min. roast period.

INLET AIR TEMPERATURE: Fixed Heat Input vs Variable Air Flow and temperatures

It must be clearly understood that the heaters put out a fixed rate of heat (10 Kw); if air flow is higher, (faster blower operation with higher voltage), the issuing air temperature into the beans is lower, and visa-versa. For example, a 6 pound charge of green coffee beans, requires less air flow to spout it; hence, the entering air is hotter, and roasting occurs faster. If 9 lbs green beans are loaded, more air flow is required for spouting; and roasting time is longer due to air which is not so hot.

SAFETY Features & Considerations

1) The heat will not be switched on, unless the blowers deliver air pressure-working
2) There is only one electrical lead to heaters, source of power - 240 V.
3) When the beans reach the set or desired temperature, e.g. 440°F, the electric heat "cut off". The blower continues to operate, to cool beans.
4) THE ATTENDANT MUST NOT, MUST NOT LEAVE THE ROASTER. Allow 5 min. for roasting and 4.5 min. for cooling the roasted beans.
5) The ventilation system carries away most of the released chaff (combustible) to the cyclone, and deposits the chaff in the 5 gallon can. "He suctioned air over the roaster also removes dust and smoke (in last 3 minutes) dilutes smoke.
6) The owner of the roaster should have a 50 amp circuit breaker for the roaster; so that any short-circuit for whatever reason, cuts-off power.

NOTE: IF blower FAILS... while roasting, immediately suction off the beans.

IF beans are below 200°F by means of the shop vacuum (on other circuit 110 V). If beans over 2000°F, make a wood frame 6" high, and with 1/4 mesh screen approx 18" x 18" for holding warm beans, but which allows air to naturally pass & cool beans.

CAUTION: A fire is unlikely, if the roaster is operated as instructed.

NOT having beans moving or power loss, when near 400°F, can cause a few beans to burn. Even a few beans can give off annoying smoke and exaggerated fire situation. In such cases, immediately cut-off heat, and switch-off circuit breaker to roaster. Lay roaster on concrete floor (clean) and hoe-out the beans onto the floor or onto metal tray. The glowing few beans will be seen and they will stop glowing and smoking in less than a minute. This is unlikely to occur, but to be prepared and forewarned is sensible.

Applying a water spray from the pint bottle, to extinguish any glowing beans.
Understanding Roasting of Coffee Beans
Degree of Roast vs Intensity of Aroma Development

Degrees of Roast

Simplified Graph by Sivetz, © 1991
Sivetz Coffee Co., 349 SW 4th Street, Corvallis, OR 97333
(503) 753-9713
A CRITIQUE ON CAUSES OF DECLINE OF:

COFFEE QUALITY

by Michael Sivetz, Ba. & Ma. Science in
Chemical Engineering
COFFEE CONSULTANT-worldwide
Manufacturer of Roasting Machinery

with 35 years industrial and commercial experiences
in the coffee industry worldwide

Outline

Pages
1-7 1. INTRODUCTION & BACKGROUND
8,9 2. ORIGINS OF QUALITY COFFEES
10-26 3. GROWING COUNTRIES-location, geography, agriculture & labor.
27-34 4. COMMERCE
Exporters, Shippers and Importers
35-57 5. CONSUMING COUNTRIES- processing and machinery manufacture
58-63 6. POLITICS: Int'l, nat'l, trade, inter related
64-67 7. CULTURAL USES: tradition, additives, variants & resistance.
68 8. HISTORY MAP
69-72 9. GOURMET SCENE
73-78 10. BREWING BEVERAGES
79-82 11. ADVERTISING & MARKETING
83-88 12. PHYSIOLOGICAL: Taste perceptions and caffeine influences
89-95 13. COFFEE PROPERTIES: Physical & Chemical
96 14. AUTHOR's Credentials
97-99 15. BIBLIOGRAPHY
100 16. Check List for Coffee Qualities

1987 Rev. March 1989

Sivetz COFFEE, Inc. phone 503 753 9713
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th ST.
CORVALLIS, OREGON 97333 - U.S.A.
1) Weigh and load coffee beans into roast chamber. Use a proper scale, and plastic mail.

2) Start blower on ventilation system. Clean out chaff can.

3) Clamp 1/4" mesh screen over top of roaster. Insert desired "cutoff" temperature.

4) Dial-up voltage regulator, which speeds up blower until beans are spouting.

5) Initially make notes of voltage used on regulator, bean temperature (read off the dial), and time in minutes. Also note bean color and when "popping" sounds occur at near 400°F.

6) Beans begin to yellow at near 2700°F; they "pop" and are light brown near 3900°F.

7) A French roast will end with about a 8°F overriding voltage. Experience will indicate the "heat cut-off" temperatures. A French roast is about a 18 wt% loss. An American roast is about a 15 wt% loss, and an Italian roast will take bean temperatures to about 468°F and a 19 wt% loss. Observe that at the end of the roast, when heat is shut off, the bean temperature continues to rise, & it is important to judge override & to cool beans immediately.

8) When the electric heat goes off, auto water spray onto the spouting beans until the bean temperature falls to below 475°F.

9) The roasted beans are immediately unloaded with plastic superior pour over.

NOTE:- The next green bean charge should be ready for filling. A just-used warm roaster will reduce the roasting time, 1 to 2 minutes.

Initially weigh roasted beans to determine roast "weight-loss".

MAINTENANCE:

Periodically, e.g. after several weeks, depending on intensity of use of roaster, it may be necessary to change air filters, if they start to reduce air flow. Also if there is some indication that stones or fine coffee particles are falling into heater chamber, these may "short" out heaters (unlikely but has occurred), so dismantling/cleaning is urged.

AIR VENTILATION & CHAFF COLLECTION

Try to arrange roaster on steel plate or concrete floor so that it can be slid out away from 10" hood duct in order to load green coffee beans as well as unload roast beans.

A 6" high gap between top flange of roast chamber and bottom of 10" vent duct is sufficient to see bean movement, with 50 watt spot light shining in.

That 6" space will also allow outside air to be sucked in, so chaff is carried for the most part into the cyclone for collection.

SEEING THE BEANS MOVING SPOUTING AND ROASTING IS AN EXCITING PART OF THE PROCESS.

The buyer provides the ducting required for vent system. Also, for blower, the buyer provides the electrical wiring.
EXPLODED VIEW
sectional

Electric COFFEE BEAN ROASTER
- 10.5 kW
240 Volts

Corvallis, Oregon

ATTENDED ROASTER
keep Coffee beans MOVING

upper cap (galv.) 12" pc
2" thick fiber glass
INSULATION
JACKET Galv.
ROAST CHAMBER
stainless steel
CONE IN TUBE

DIAL Thermometer insertion - importance
or Thermo couple

perforated cone tip
perforated radiation shield(s) optional

sheet metal screws

4 holes for bolts to base plate

Resistance HEATERS -
12 kw

HEATER support plate steel

ceramic insulators (wire)
6 legs 1/4" rod (4.75" height span)
SUPPORT for heater plate

ceramic insulator enclosure

4 screws & washers
BASE PLATE

air pressure probe (option)
pressure blower

AIR FILTER

NO SCALE

Rev. 8-79
2-80
10-81
DISMANTLING INSTRUCTIONS for 3.4Kg (8 lb)/6 1/2 Kw ELECTRIC Coffee Bean Roaster

It is advisable to have a "clamp-on" ammeter to ascertain when full current is not being drawn, to confirm if a heater element has burned out. For example, each heating element (Q 39585) puts out 3.5 Kw heat at 240 volts. 3 heaters will put out 10 1/2 Kw, each draws 15 amperes @ 240V.

If one element burns out, the amperage will fall 15 amp.

Roasting will be prolonged or become impossible because inlet air temperatures are too low. Having confirmed this situation, dismantling is required to replace the "burned-out" heater. Spare heaters or replacement coils should be on hand.

TIME TO DISMANTLE AND REASSEMBLE ROASTER when skillful takes about one hour.

1) Disconnect from power source. Work on clean bench. Have tools ready.
2) Unscrew sheet metal screws to remove forward front panel. Then slip off 3 sided panel. 
3) Unscrew 8 small sheet metal screws at base flange (note orientation to plate). Lift off 3/4" D stainless steel tube carefully.
4) Now the heaters are revealed. Visually inspect for broken resistor wire.
5) REMOVE 1/4" nuts that hold heater support plate to gain access to underside of heaters. Two screws (sheet metal) hold the heater plate from below; REMOVE SCREWS.
6) A two electrical wires to faulty heater.
7) REPLACE NEW HEATER; wires and support screws.
8) TEST that all heaters are working. 3 "short out" Dwyer pressure switch wiring terminals. Push heater switch "on" for 3 seconds only enough to have heaters glow red to confirm that all are working. IMMEDIATELY switch off power. Disconnect power cord from Dwyer "short".
9) RE-ASSEMBLE stainless steel tube with 12 sheet metal screws. Make sure tube is properly oriented and seals firmly to base plate (to avoid air leakage out).
10) RE-INSTALL insulated 3 sided jacket to base plate. Then front panel with sheet metal screws and then two top press fits.

If untrained qualified to do this work, please have a qualified electrician or appliance repair man do work. Phone me if there are any questions. Any repair work undertaken is under your own RESPONSIBILITY. NO ROASTERS or PARTS are to be returned without permission and disposition.

Such disassembly and vacuum cleaning is recommended periodically, since charred coffee beans or stones (foreign matter) can fall through cone holes onto radiation plate and into blower plenum base plate.

A carefully taken care of roaster will give years of service with only heater element replacement.

INCREASED PRODUCTION without heater replacements and less labor, can be obtained with the SIVETZ line of gas fired automatic cutout roasters.
Coffee Bean ROASTING DATA

SIVETZ COFFEE CO.
349 SW 4th Street
Corvallis, OR 97333
(503) 753-9713

1. ROASTING MACHINE

2. GREEN COFFEE BEANS:
   a.- TYPE & QUALITY
   b.- WEIGHT .... Kg ..... lbs
   c.- DENSITY .... grams/ liter

3. PURPOSES:

4. ROASTED COFFEE BEANS:
   a.- WEIGHT Kg ..... lbs
   b.- YIELD wt %
   c.- LOSS wt %

5. TASTE

6. ROASTING DATA:

   | TIME | TEMPERATURES OF | BLOWER | COMMENTS |
   | min. | inlet AIR | BEANS | Volts |

   CONCLUSIONS & RECOMMENDATIONS


MAINTENANCE

Although there is very little work to be done, some repairs and cleaning are very important:

1. REPLACEMENT OF "BURNED-OUT" HEATER (see dismantling instructions).
2. KEEPING ADEQUATE PARTS ON HAND, e.g. heaters.
3. INLET AIR FILTER must be kept clean. Spares can be obtained from Sears.
4. Lighting must be kept up.
5. Room ventilation must be always in working order.
6. Roast bean unloading may be done with a plastic scoop, shop vacuum, or pour out. These tools must be kept clean and handy.
7. There should be no encrustation on roast chamber walls. If such develops then it should be scoured off, by laying roast chamber on side on table.
8. Care should be taken not to allow any foreign matter to fall into perforated air inlet at base of roast chamber.
9. Since some charred or broken beans may fall thru these perf. holes, the interior of the heater section should be thoroughly cleaned out when a heater is replaced.
10. There ought not be any dangling wires, worn wires, overheated wires, and the circuit breakers on both the 240V & 120V lines must always be in working order.
11. An assortment of proper tools, "is necessary to reduce the effort and time in replacing heaters and dismantling.
12. The 2" fiber glass insulation may get worn after several years, and it must be kept in first class condition.
13. It is advisable to keep a maintenance log book, as a useful record on possibly repetitious repairs.
## Coffee Bean ROASTING DATA

**SIVETZ COFFEE CO.**  
349 SW 4th Street  
Corvallis, OR 97333  
(503) 753-9713

---

**DATE** 3/6/90

*by [signature]*

---

### 1. ROASTING MACHINE

[8/6]

### 2. GREEN COFFEE BEANS:

- **a. TYPE & QUALITY**: [description]
- **b. WEIGHT**: Kg [weight]
- **c. DENSITY**: grams/liter

### 3. PURPOSES:

---

### 4. ROASTED COFFEE BEANS:

- **a. WEIGHT**: Kg [weight]
- **b. YIELD**: wt% [yield]
- **c. LOSS**: wt% [loss]

### 5. TASTE

---

### 6. ROASTING DATA:

<table>
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<tr>
<th>TIME</th>
<th>TEMPERATURES OF INLET AIR</th>
<th>TEMP. OF BEANS</th>
<th>BLOWER VOLTS</th>
<th>COMMENTS</th>
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**COMMENTS**

CONCLUSIONS & RECOMMENDATIONS
SAFETY CONSIDERATIONS

SAFETY starts with reading this manual.
And SAFETY means that the installer and operator understands how all components work.
If at any phase there is not competency, get a qualified electrician, technician or service man.

Phone us on any questions.
The following list is simply a guide:

1. Is your circuit breaker rated at 30 amperes at 240 volts?
2. Is there adequate lighting in work area, and a spot light into roast chamber?
3. Is the 120 volt supply to the blower voltage regulator on a separate breaker?
4. Have you installed an adequate room vent fan?
5. Is the floor concrete or steel sheet over wood?
6. Are your service people: electrician, operator, etc. skilled at their trades?
7. Have you itemized the spare parts you need?
8. Are you attending the roaster all the time?
9. Are you monitoring the bean temperature dial thermometer frequently at end of roast period?
10. Are you there at the end moment to apply a few shots of water spray to stop roast?
11. Are you cooling roasted beans back to room temperature?
12. Do not go over 475°F on Italian bean roast, because beans can be ignited over that temperature.
13. Are you prepared to deal with beans if a fire occurs?
14. Is your installation safe relative to not endangering a residence, etc.?
15. Are you fully aware that the 3 lbs green beans is a working load, and it should not be increased; nor decreased below 1.5 lbs?
16. Chaff is very combustible.
   Be sure to keep the top screen free of chaff, if screen is used.
   Be sure to vacuum chaff off floor frequently.
17. Red pilot light indicates electric heating is ON. 
18. Do not work when tired, because carelessness sets in.
19. Do not allow yourself to be diverted by talking to visitors, etc.
   Full attention to the manual roasting is required for safety and accuracy.
20. All wiring must be installed according to code.
Examining the degree of roast

by Michael Silvetz

SIVETZ COFFEE CO.
349 S. W. 4th Street
Coralville, IA 52243
(503) 753-9713

The growth in the gourmet coffee retail trade since the early 70's in the U.S. has been punctuated by the setup of the Specialty Coffee Association of America (SCAA), by the offerings of individual varieties of roasted coffee beans from original sources like Kona, Celebes, Java, Sumatra, etc., and at various levels of roasts. The Coffee Development Group (CDG) formed in the mid 80's sponsored and supported by the ICO (International Coffee Organization) has prepared a number of general descriptive posters and flyers in order to educate the public and retailers about coffee.

In this period, there also have been over 200 new retail and wholesale roasters setting up new businesses, many of which have been quite successful.

In all this growth and education, I have prepared and sold several books, namely: Coffee Technology, Coffee Origin & Use, and Coffee Quality, which have been sold both to new and traditional coffee roasters. The SCAA has organized a number of trips to coffee growing areas to help educate their members, e.g., Kona, Kenya, Jamaica, Costa Rica, and future trips to Indonesia and more.

However, amid all this growth in knowledgeable people and consumers there have been some serious lack of standards. Because different roasters service different markets, many are not truly knowledgeable, nor are they absolutely ethical, and this confusion has hurt the integrity of what is generally known as the retail gourmet trade.

Authenticity of coffee bean origins are not always strictly used, freshness of roasted beans are often lacking, beverage preparations are frequently unsatisfactory, and so the consumer is confused and disappointed. It would take a book to cover even the several variables mentioned, but there is one aspect I'd like to address, and that is the generally communicated levels of bean roasts.

The degree of bean roast is critical to proper flavor development, and usually at the retail level, it is not adequately defined. Even worse, many wholesale roasters do not have accurate roast standards and do not properly speak of roast standards as they should recognize.

On top of this we have cultural and microcultural nomenclature and traditions that confound what is offered and what is requested by the consumer. I would be speaking for myself, but I've had many roasters in the trade ask me to make a clarifying statement regarding this, especially dark roasts.

But first a word about light roasts. Across the U.S., there is a wide difference in taste preference and use on roasting. On the East Coast and in the Midwest, a light roast is predominant. In the South a darker roast than the East Coast is more evident, but in the West, Southwest, and southern Florida, dark to burnt roasts are used.

It is important to understand where burnt roast beans occur and why. There are two basic reasons for this: historical, and the type of coffee beans used.

Historically, going back perhaps 100 years and to Europe, especially the Mediterranean coastal area countries, primitive roasting equipment was used, which resulted in scorched beans and oil release that coated all beans. Also low grade coffee beans with many defects will burn and scorched more readily than wholesome beans, causing non-uniform roasted bean colors and tastes. Further, the degree of roasting was an art form where the operator grew to know his machine and how it performed and related "the degree of roast" to his final objectives. With this background common terms like French and Italian roasts were evolved, without any real scientific basis.

What many people do not realize is that a proper Italian roast is not acrid when properly done with good quality beans. Oiliness comes from a cylindrical roaster that is so hot it scorches many beans, and from the manual control of the operator and his judgment and also from lower quality beans. In fact there is a wide use of low grade beans in dark roasts because sometimes the roaster has an attitude, "that if I'm going to burn the beans, why should I use good beans?"

On the contrary, because dark roasts can cause scorching and fires and not develop a uniform bean roast with non uniform beans, it is all the more important to get a dark yet not oily roasted bean.

Degrees of Roasts

I wish to explain the scale of roasts used commercially. This can be related absolutely to the roasting weight loss (w/o water add back), to the final highest bean temperature and to the roast bean color. Colors can be measured on various reflectance instruments from scans of coffee grounds and is a routine measurement with many large commercial roasters. Bean temperatures can only be measured in fluid bed systems.

Roast weight loss can be measured on any system, but only after the roasting process is completed, by weighing the roasted beans and dividing the original weight of green coffee beans.

The general relationship between end-bean temperature, and roast weight loss, virtually independent of roast times in the 5 to 18 minute range, can be categorized in general as follows:

430 °F A light roast with about 14 wt percent loss or slightly less. This gives a very acrid tasting cup, usually astringent with little coffee aroma, but is widely used in the hotel and restaurant trade in the U.S.

440 °F A more developed roast flavor but still on acidy side, less astringent. Widely used in canned coffees, although 430 °F may also be used.

450 °F Very close to an optimum flavor roast (maximum aromatics).

460 °F Possibly just past an optimum flavor roast. NOTE: Different coffee beans, of varied origin and growth sometimes require final roast bean temperature different from other origins.

460/465 °F European roast, often referred to as Viennese in U.S. retail shops.

470 °F to 475 °F is a genuine Italian roast, that when made with top quality coffee beans is uniformly dark brown and not oily, and it is what would and does make excellent espresso demitasse coffee. Real desirable coffee flavor can be tasted without harshness or burnt taste or burnt aroma. The roast loss is close to 20 wt percent.

In Europe most connoisseurs recognize this roast and taste level. Unfortunately, in the U.S. and in Latin America where low grade beans high in defects are used to prepare dark roasts and oiliness appears that is recognized by the uneducated at their traditionally roasted coffee beans. It is their tradition, but that is not properly roasted or quality beans. Of course, such commentary brings emotions to higher levels, but in fact it is the truth when properly examined. The undesirable result of such consumer concept is to ask the roaster to go to 485 °F and take a 23 wt percent loss.

Here we have lost a lot of the real coffee flavor an have introduced a definite burnt note. In the extreme some consumers even ask for darker coffee when roast losses reach 25 wt percent, and in my experience shouldn't even be prepared.
Example: The degree of loss

\[ \text{Sum for C2a's} \]
\[ \frac{9 - 11}{9} = 380 \]
\[ 470^\circ \text{ plus } 20 \text{ sec} = \text{darker} \]

\[ \text{Col. for C2a's} \]
\[ \frac{6}{9} = 391 \]
\[ 470^\circ \text{ plus } 40 \text{ sec} = \text{darkest} \]

\[ \text{Sum for C1's} \]
\[ \frac{9}{9} = 380 \]
\[ 485^\circ \text{ plus } 10 \text{ sec} = \text{dilute} \]
\[ \theta \]
\[ 490 \]