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TRIP TO RCA (LANCASTER) - FEBRUARY 24-25/48

The following notes were made at the RCA plant in Lancaster, February 24-25/48. Our main contacts were Messrs. Burton, Artan and Pratt.

RCA are currently producing, per month, approximately 25,000-10FP4's, 500-5TP4's, 3000-7JP4's, 100-200-7DP4's and a few monitor tubes and oscilloscopes. (Their monitor tube, comparable to our 10DP4, utilizes a 10BP gun in an aluminized 10" bulb.) Their ultimate schedule has been revised downward since our last visit to approximately 35000 per month on 10BP4's. They are not at present planning production on the 10FP4 or the 12" direct view tube, but expect to schedule the 16" direct view tube (metal bulb) some time this year.

Their labor load is 250 people (all shifts), including set-up men and secondary supervision. They expect this number to decrease, even with increased production, as more and more automatic equipment is brought into use. As examples, they anticipate one operator per two exhaust machines at one tube per minute each, one operator per two settling belts at 50 tubes per hour each, etc.

It was noted that all planning has been done with a view to minimizing the delay required to change the major type, i.e., to 5", 7", 12". The 16" tube would require rather extensive work on exhaust, etc., equipment.

Most of our attention was devoted to 10BP4 processing, and except as otherwise noted, the following notes on the various operations apply to this type.

BULB BUTTONING

RCA does not purchase buttoned bulbs, although samples have been run. They find a higher-than-normal shrinkage on such sample lots, due to cracked buttons.

All J84 bulbs are buttoned on the rotary machine. It is used for both new and salvage bulbs; the buttons are not beaded, in either case.

Changes on the machine since our last visit include:

(1) Moving the insertion equipment two positions further along

(2) Using a shield on the face. This shield extends up over the side of the bulb to approximately the face-seal line.

(3) A gauge has been installed to check bulb-neck alignment.

Shrinkage at the operation to date for February was 0.6% from all causes. They have recently had considerable trouble with thin

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walls on Corning necks, running as low as 0.010" at the seal (this has necessitated a 100% check at incoming inspection, as they feel that .060" is the absolute minimum that can be used without incurring additional shrinkage.).

Two operators are used on the machine, and produce 72 bulbs per hour. This includes unpacking the bulbs.

The overhead lehr is operating on a 1 hour schedule; no attempt is made to anneal the face, which is kept protected, but the cone is held at 440°C for 10 minutes. After this treatment the bulb is "strain free".

BULB WASH

All bulbs except those which have been painted, are washed in the machine (a second similar machine is to be installed); screen material from bulbs with rejected screens is apparently not troublesome.

A production of 120-40 per hour per operator is obtained.

The washing cycle is as follows:
(1) Caustic soda (6-8% by wt.) for 1/2 minute.
(2) Hydrofluoric acid (4-6%) for 1/2 minute.
(3) Caustic soda (6-8% by wt.) for 1/2 minute.
(4) Tap water for 1 minute.
(5) Distilled water for 2 seconds.
(6) Hot air dry (steam-heated air) for 1 minute.

Open end pipe is used for the jets, which are located approximately 1 1/2" below the seal line.

SCREENING

(A) The screening belt is being used on approximately 20% of the bulbs and Mr. Neff indicated that their screen shrinkage on these bulbs is lower than on regular bulbs; nevertheless, it apparently is not being used when there are sufficient bulbs produced by the regular method. Attachments were being added to the return belt to- (1) wash the neck of the bulb in HF, to remove residual silicate from the pouring operation - (2) to rinse twice in tap water - (3) air dry.

This was to be done by raising a tank (or pipe rack) in one position, moving the tank (or pipe rack) with the belt until the next position had been reached, and then dropping it down and moving back to the following position.

The machine operates on a one hour settling schedule.

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(B) Automatic powder dispensers are used on all lines (except 5TP4 and P7). The tanks are of cast aluminum, approximately 16" deep. Fig. I shows a plan view of the tanks; the outlet holes A are 1" diameter, and the 2" propellers are offset from the center of the tanks in the direction shown (the propellers are located approximately 1 1/2" above the bottom of the tank, and the shafts are tilted at approximately 18° to short side of the tank). The dispensers give ± 1 1/2% variation in powder batches (by weight of powder).

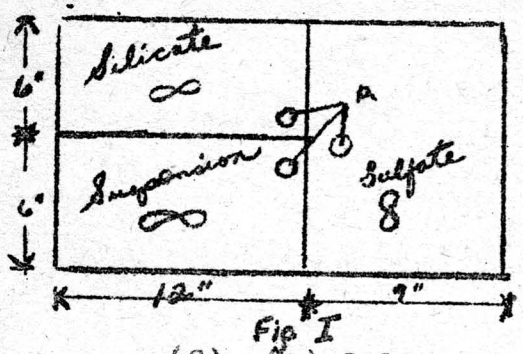

Fig. I

(C) (i) Silicate:

The peroxide bleaching for silicate purification is no longer being used, and has been replaced by the following procedure:

(a) The silicate is diluted from 24% to 10% and placed in a Pyrex bottle (4 litre, g.g. stopper). Triple distilled water is used.

(b) 0.25 gm. per liter C.P. Zn S is added.

(c) The bottle is placed on a shaker and agitated for 5 minutes.

(d) The suspension is poured to a stainless drum, from whence it is forced with air pressure thru a small "Alsop" pressure filter (These filters appear to require less maintenance and to provide a thicker filtering medium than the Büchner type. They require 10-12 lb. air).

(ii) Sulphate

Anhydrous Bakers C.P. sulfate is dissolved to make a IN solution in triple-distilled water. They find that solutions much stronger than IN will tend to precipitate on standing.

The solution is filtered thru an Alsop pressure filter, as noted above.

(iii) Powder Suspension

The powder is milled for 20 minutes in a gallon mill containing 300gm. of 1/2-3/4" pebbles. The suspension is 50g.p.l. in triple distilled water. After this treatment the average particle size is 7-8 microns, the maximum is 25 microns.

This suspension is diluted to 12.5 mgm/cc before being placed in the batch dispenser.

(iv) Distilled water

Two distilled water supplies are available i.e., the older installation wherein condensate from the heating system is run

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thru a Stokes still, and then thru a Barnstead type Q to glass storage in a refrigerated - (56°C) room (this water is used in all material preparation and is available in the screening area if required), and a new system using an Illinois demineralizer and Barnstead 200g.p. h. double-effect stills.

Mr. Horvath was able to obtain considerable information regarding installation, operation and maintenance of this new system. A scheduled test is run on this water for copper, with a maximum allowable limit of 0.02 p.p.m. A simple colorimetric test, which does not involve a colorimeter, is used. (Details will be given later)

The general screening procedure has not been changed, i.e., the screens are applied at a sink, transported with the screen in suspension to settling racks (settling time is 1 1/2 hours), and then transported to the pouring racks. Pouring time is 8 minutes.

In using the dispenser, the cushion water is added first to the bulb, then the powder suspension and both binders (note that the powder suspension is mixed with the concentrated binders), and finally a water flush. The timer is set such that there is no break in the liquid column in the screening funnel between the addition of the powder and the water flush.

Pouring tips are used on glass screening funnels, with a 325 mesh sieve. The tip is held approximately 2" above the water. Open-end funnels are used on all bulbs smaller than 10", but on this type they feel that the improved distribution obtained with the tip warrants its use.

The batch per bulb is as below:

(1) Cushion	1200cc	plus 460cc flush.
(2) Silicate	150cc	
(3) Sulfate	250cc	
(4) Powder suspension	143cc	

It was noted that all bulbs were rinsed with distilled water before screening, even though previously rinsed in the bulb wash machine. Tests were being run to eliminate this pre-screen rinse.

The water from the new system reaches the screen room (a) 65-75°F. The room temperature is maintained approximately 2°C above the water temperature as an aid to obtaining improved screen distribution.

The main shrinkages are holes, dirt and "machine lines" caused by disturbances on the tilt racks.

Screen Inspection

Fluorescent inspection utilizes fluorescent (transmission), ultra violet and spark check.

All bulbs pass thru the fluorescent box. Following painting and bakeout, 25% of the bulbs are spark checked; if dead spots run greater than 1% the remaining bulbs are sparked 100%. (These "dead spots" are apparently inactivated phosphor.) Otherwise, the remaining 75% is subjected to an U. V. inspection only.

The U. V. inspection equipment is new. Two bulbs are placed face up in a box, and the lid, which contains eight ultra-violet lamps (four per bulb) on the circumference of two 10" diameter holes, is lowered over them. A high intensity is obtained.

The screen specifications used on all above tests are as follows.

a) Within a 6" diameter circle allow a maximum of 2 defects, .020" maximum, minimum separation 1 1/2". Disregard spots ≤.010"

B) Between the 6-9" diameter circles, allow a maximum of 2 defects, 0.030" maximum, minimum separation 1 1/2". Disregard spots ≤.010".

These defects are for screens only, and are allowed in addition to the glass defects. However, the final inspection uses the RMA bulb defects as limits so that a bulb having the maximum number of bulb defects does not allow any screen defects.

Bakeout

Two bakeout schedules, as follows:

A) Approximately 25% of the bulbs are baked once around a rotary oven on a 6 minute index, with glass face temperatures as below:

Elapsed time	Temperature °C
7	100
14	180
19	250
26	310
32	340
38	370
42	380
46	395
58	395
62	360
68	315
76	215

B) The remaining 75% of the bulbs received a double bake.
   a) Once around a rotary oven on a 2 minute index with a maximum glass face temperature of 200°C.
   B) Thru the lehr on a 3 1/2 hour cycle (3.5in./min). The maximum face temperature is 465°C, and the face is held above 430 for approximately 45 minutes.

The new straight line oven was not in operation; however, the following items were noted:

1) The bulb capacity is 325 bulbs
2) The expected production is 130-180 per hour. (This would supply three straight-line ovens on a 1 minute index).
3) Flushing air is used.

The equipment consists of a number of wagons which move from one end of the oven to the other at floor level, are hoisted up to the second level and return to the load end. They are then unloaded at ground level.

Electric heat (300kw) is used and is sufficient for annealing, if required.

Exhaust

Approximately 3% of the tubes are run thru rotary machines, the remainder being exhausted on two straight line ovens. One of the rotary machines uses oil pumps, the other two being mercury.

A) Rotary Exhaust

1) Pumping and liquid air

Pos 1	Kinney	
2, 3, 4	Kinney	
5, 6, 7	Kinney	Raise air in 5
8, 9, 10	Kinney	
11, 12	Kinney	Add air in 12
13	Hypervac	
14	Megavac	
15	Megavac	
16	Megavac	

11) Activation and bombarding

Position	Grid °C	Gun °C	Ir	Gl	Getter °C
11	-----	700-750	----	----	850-900
12	-----	700-750	----	----	850-900
13	750	--------	----	----	--------
14	800	--------	.5	----	--------
			.6	----	--------
			.75	----	--------
15	-----	-------	.9	----	--------
			.7	----	--------
			.7	----	--------
			.6	----	--------
16			.6	----	--------

tip

The same schedule is used on 6 minute or 10 minute index (Aluminized 10" tubes are run at 10 minutes, and non-aluminized at 6 minutes); the I_f changes in positions 14 and 15 are at 1.5 or 2.5 minute intervals, depending on the index.

(111) Bakeout

The bulb face reaches 390-400°C for approximately 6 minutes.

The oven temperature in the first oven position is 400°C (upper) and 135°C lower. They believe that any breakage due to heat shock or strains occurs on the cooling cycle.

The face temperature curve, on a 6" index, is

Position	°C	
1st in oven	250	
2nd	325	
3rd	350	
4th	400	
5th	400	
6th	375	- End of heated oven
7th	325	
8th	275	
9th	225	- End of oven

B) Straight-line Exhaust

Two machines are in operation and a third is on order. The index on the one machine with auto tip-off is 1 3/4 minutes, and on the second, with manual control on tip-off, is 2 1/2 minutes. The ultimate anticipated index for these machines is 1 minute. At present they are operating three shifts.

(1) Bakeout (on 1 3/4 min. index)

Position in oven	Face °C
2	50
8	180
12	280
16	350
18	390
20	375
23	330
28	275
32	200
unload	160

(11) Activation

Getter degas and mount treatment is completed before the heater is lit.

Position in oven	I_f	G1
25	.4	
26	.5	
27	.6	

Position in oven	I_f	G1
28	.7	
29	.8	+5 v.dc
30	.8	+5
31	.8	+10
32	.6	+10 -
33	.6	+5
34	.6	+5

The same voltages are used on both machines, irregardless of the index time.

Basing

The eight head infra-red oven operates at 1:1 tubes per min. It has been altered somewhat, and uses one lamp per tube, with a reflector on the opposite side of the base.

The cement is not baked to a brown i.e, remains a fairly deep green.

Immersion tests are run on five tubes per day; the breaking torque runs 80-100lb.

Soldering

50:50 tin-lead is used (a)395°; the temperature is varied ± 15° from this to give optimum conditions.

Nokorode flux is used, followed by a water wash. The amount of flux is rather carefully controlled to give a flat tip i.e., an excess will cause the solder to suck up too far in the pin; too little will give a rounded tip.

Spark and Age

The following schedule is used on 10B's, and 7D's.

I_f	1st Anode	2nd Anode	1st Grid	Time(min.)
12	0	0	0	2
7.8	500	140	-5	30

The same schedule is used on 5T's, 7G's and 7J's, except that the second step is continued for one hour.

One of the ageing racks is fitted up for sparking after aging, and these tubes are sparked with 15-1800v. for 1 1/2 minutes between G1 and G2. Tubes from the other racks are sparked for one minute @ 18000v. between the 2nd anode and all other pins.

Shrinkage on initial test runs up to 3% for leakage and breakdown.

Testing

Four new test sets are being built, of which one was on the floor. The cabinets are very similar to their older sets, and the sets will make all tests. However, certain short cuts have been built in eg to automatically set the 6X8 raster, 35 volt modulation, breakdown voltage etc.

Standard rate is 42 per hour per set. This rate is being exceeded and the standard is being raised to 50 or 55 per hour.

The sweep generators are in a completely separate cabinet, the whole unit being replaceable should breakdown occur.

A The following tests are made 100% on production tubes. All tests, except as noted, use 9 kv on the anode and 250v on the second grid.

(1) K-G and H-K shorts, tested in the preheater. Two minute preheat is used on initial test; five minute for salvage testing.
(2) Breakdown and stray emission at 12kv. Tubes are rejected for all degrees. Tha ambient light is 2-3 ft. lambert.
(3) Cutoff. Factory limits 29-60 volts.
(4) Color control limits are 6000-8500°. The two filter system is used i.e., does not measure variation from the black body lines.

Each lot of phosphor, which lasts approximately 5 days, is tested as tubes on the spectroradiometer.
(5) Modulation, using 6 X 8 raster. Grid drive limit is 35 volts maximum for 20 ft. lamberts.
(6) Cathode current. Limit is 150μa factory or 300μa customer for 20 ft. lamberts.
(7) Beam Strikes neck. A 1/16" spacer is inserted between the yoke and the reference line, as a safety factor. The quality circle is 9 1/4 " diameter.

(8) Screen condition. The allowable defects are according to the RMA bulb defect schedules i.e., bulb and screen defects combined should not exceed these limits.
(9) G1 leakage. 3μa maximum
(10) Anode leakage 10μa maximum
(11) Gas. PIb is set at 500μa. Factory limit 0.4, customer limit 0.5.
Note that spot centering, gun alignment, emission or cathode condition are not checked.

B) Record readings are made on 20 tubes per week in the laboratory, as follows:
(1) H-K 1kg. (125v HK)
(2) H-K surge (500v HK for 15 sec).
(3) A2 and G1 leakage, using 10 meg in grid circuit (a low resistance is used in the grid circuit for production testing
(4) A1 leakage
(5) Breakdown and stray emission.
(6) G2 current (maximum allowed ± 10μa)

(7) Ion trap current (100μa bogie)
(8) Cut-off
(9) Color (two-filter).
(10) Modulation
(11) Cathode current
(12) Beam strikes neck
(13) Screen condition
(14) Focus coil current. Bogie is 105. The coil used is a G.E.#CG30962.
(15) Resolution, at center and all corners.
(16) Mb2 at zero bias
(17) Gas
(18) Heater current
(19) Outside coating resistance

C) Life test is run on approximately 10 tubes per month, under the following conditions.

A2 = 11kv
EC2 = 400
6 X 8 raster

Test is continued @ 13 min. on and 7 min. off, for a total elapsed "on" time of 500 hours. The end point is reached when any of the initial test limits are exceeded.

D) Spot checks are run daily, as follows:
1) Base immersion, as previously noted.
2) Resolution, on 5 tubes per shift.

The production limit is 500 lines at 20ft lambert highlight brightness. If the average of the five tubes runs 500-650 lines, the tubes are tested 100%; if the average is greater than 650 lines, no further testing is done

3) Pressure test on approximately 10 tubes per shift at 35 p.s.i. gauge.
4) Outside coating resistance on 10% of the production. The resistance is read between two 1/2" diameter spheres located 1 1/2" center-to-center. Three separate readings are taken on each tube, with a maximum of 9000 ohms allowed.

E) Procedure:
After initial production test the tubes are sampled according to an Army Ordinance sampling schedule (eg 75 out of a lot of 800-1300), the remainder being sent to the warehouse. The sample is retested for (1) stray emission(2.7% in sample allowed) (2) mechanical tests (1% in sample allowed) (3) all other electrical tests (1.7% in sample allowed).

If these limits are exceeded, (this has happened twice in six months) a second sample is made on the lot for the defect concerned.

There is apparently little opportunity to make a 100% retest, since the tubes are currently being shipped 3-4 days after manufacture. (They have warehouse capacity for approximately 20000tubes).

Filming

Both 5" and 10" tubes are being filmed by a spray method, according to the following procedure.

1) The screen is baked thru the lehr i.e., 450°C maximum face temperature, 3 1/2 hour cycle.

2) The screen is covered with water, and then the water dumped out. Operation time approximately 5 sec.

3) The bulb is placed face up on a rotating ring over a spray gun and the film sprayed on. Operation time is 2 sec. for both 5" and 10" bulbs.

i) The film material consists of 60gm isobutyl methacrylate dissolved in 250cc. toluene by rolling for approximately 3 hours and diluted with 65cc of a mixture of 130 parts toluene and 60 parts acetone (vol).

ii) The gun is an Eclipse Air Brush, N¥G680, using a N°2 tip nozzle with an 18" extension and an .060" opening in the fluid tip. It is all-stainless construction (aluminum would be satisfactory but this gun was the type previously used for spraying P1 screens).

iii) Bulb rotation 80rpm.

4) The bulb is placed face up on a rotating ring for 15 sec. @ 600 rpm. This operation tends to smooth out the film but apparently does not effect any spreading.

5) After draining for approximately 6 min. the excess varnish on the inside of the bulb is swabbed out. A water jet on a soft bristle brush is used.

The drying time is long enough that the excess film can be removed in large pieces, but is not so long that the water has evaporated from underneath.

6) The bulb is placed on a drying rack for 10-12 min; a high air flow (300-400cf/hr) is used.

The films appear to be very thick i.e., above the interference range, but have exceptionally high glass.

Shrinkage on 10" bulbs is 5-10%, and 60-75% on 5" (the high shrinkage on the 5TP4 is due to the very tight allowable defect limits allowed i.e., one spot maximum .005" , per bulb.)

Aluminizing

Apparently little work has been done on this equipment since our last visit. The six position bell jar is used for 5TP4's, and the single head, rotating filament device for 10" (uses a VMF50 andCenco backer).

Aluminizing vacumm in both cases is stated to be approximately 0.1 micron or less.

A glass tube is slipped down over the electrodes and adjusted to shield the lower cone and neck from aluminum.

Bulb Inspection

Raw bulbs are inspected for face blemishes according to RMA published limits. RCA are proposing a new specification to replace those currently in effect; details were obtained.

Incoming bulbs are sampled according to Dodge and Romig tables, and the samples are inspected for (a) major defects (which will give a rejectable tube) and (b) minor defects (cone and neck defects, dimensions, etc.). 1% major defects and 3% minor defects are allowed (this automatically means that all face plates will be inspected 100% since major defects run as high as 15%)

Face plate inspection is done without removing the bulb from the box (i.e., a fixture containing a number of lights is inserted into the carton around the circumference of the face plate.)

Major defects are such as blisters, seeds, rouge, stains, scratches, scuff, inside surface defects (water wash is used to determine whether blemishes on the inside of the bulb are actually blemishes or not) and dirty molds.

Minor defects are thin walls (separate checks are made on the top wall, the rim and the cone, using a L. and N. optical -- thickness gauge), outside diameter, neck diameter (outside), reference line to face (the bulb is placed upright in a split ring gauge and a dial gauge used to take the reading), neck alignment and face plate tilt (the Libbey roller gauge is used), scratches on rim or in seal zone, neck ID and shear marks. (Shear marks with reverse rolls have caused considerable shrinkage).

Five bulbs per lot per vendor are pressure tested at 55 psi gauge for 1 minute. Results are used as a basis for complaint only.

Shrinkage etc.

A The following shrinkage percentages were obtained for the types noted. They were read from daily shrinkage curves and thus are only approximate.

Type	Floor	Test	Gross	Retest	Net	Salvage (good)
10B	5	10	15	1	6-7	10
5T	8	50	55	12	30	25
Scopes	3	10	13	4	10	8

B Screen room and bulb preparation shrinkage (10BP4) runs approximately 28% (not including approximately 0.6% at the button inserter)

C Total glass scrap (seal, exhaust, air tubes, etc.) is approximately 3%, although periods up to 6% were noted. These defects are mainly

cracked stems (up to 3%)

D Record reading charts indicated
(a) C.O. average of 42
(b) Considerable variation above and below color control limits. Average probably 6800°.
(c) Gas usually below 0.15, with three periods since January 1, 1948 showing gas out of control (above 0.4).

E Mr. Burton estimates bulbs screened; tubes packed at 1.5:1.0.

F Test shrinkage is mainly stray emission, leakage and breakdown. Apparently the ceramic mount gives trouble, and in spite of the sparking noted previously, practically all tubes, if repeatedly tested, will show some grid emission.

Miscellaneous Notes

(1) An all-silicate screen is in use on the 5TP4 i.e., the regular Zn Be silicate with a Ca Mg silicate blue, approximately 1:1. This screen has only approximately 60% of the efficiency of the silicate-sulfide, but is said to give no color shift over a wide range of brightness.

(2) Purple spots ran 34 bulbs out of the last 25000, although this was apparently better than normal. An average of 1 1/4% was given.
Some control has been obtained by
(a) Repiping the demineralizer (using Saran and rubber)
(b) Cleaning and repiping part of the water distribution system.
(c) Improving filtration on silicate and sulfate.
(d) Standardizing on C.P. Bakers sulfate, with control tests on each lot.
It was found that Mallinkrodt sulfate will give 100% purple spots, Merck and "B & A" from 1-50%, according to the lot but that the Baker material runs consistently good.

(3) A converted vertical sealing lathe is used to open tubes, and gives a sharp, clean break.

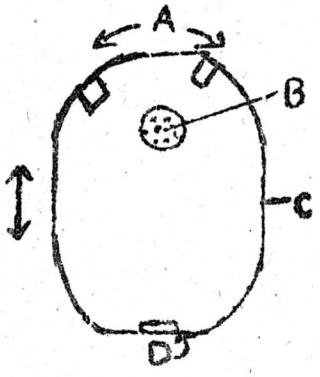

Fig 2 shows a top section. The two fires A are moved up to the rotating neck B for approximately 8-10 seconds. Then, the supporting ring C is moved in the direction shown until the water cooled edge D comes in contact with the neck.

The mechanism can be adjusted vertically to enable the neck to be cracked at any point. Short 2-4-6" sections are used for re-necking, where possible.

(4) A converted drill press is used to grind scratches, etc., on the face, and a flexible shaft grinder for polishing. Two grades -

of pumice are used.

(5) All stems are annealed thru the lehr. This includes the metal-tubulation stem for 10BP's, as well as the all-glass stems used on other types. (The standard lead is 2 piece with a nickel inner lead and dumet outer)

(6) Details were obtained of a device for examination of the inside of the bulb cone, used to evaluate glass distribution at the button seal.

(7) Outside painting capacity, including washing andpainting, is 360 per hour maximum. Four operators are used to load, unload and pack.

(8) All ovens, etc., are designed and operated to give a maximum decrease in glass temperature on the cooling cycle of 22°C/min.

(9) Approximately 300 bulbs per month are rejected at screening because of glass defects, i.e., rouge, blisters, stones, etc., that have slipped thru inspection.

(10) Kasel-Meyer test for Copper in distilled water.

Reference: Colorimetric Methods of Analysis (Snell).

Reagents: 1) 2gm phenolphthalein with 20 gm reagent KOH dissolved in 100cc copper-free distilled water (the water from the triple-distilled setup indicates no copper, when tested by this method)

Boil with 10gm Zn dust until decolorized. (this reagent is made up weakly and is reboiled whenever it begins to turn color).

ii) 3% H_2O_2

iii) Copper standards (standard solutions are made up in copper-free water @ .04, .02, .015 and .01 ppm)

Procedure: 1) To 10cc sample add 4 drops phenolphthalein reagent.
ii) Mix and add one drop of 3% H_2O_2
iii) Allow to stand 15 minutes and note color. The colors are transient, and duplicates are run with the standards at each determination.

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