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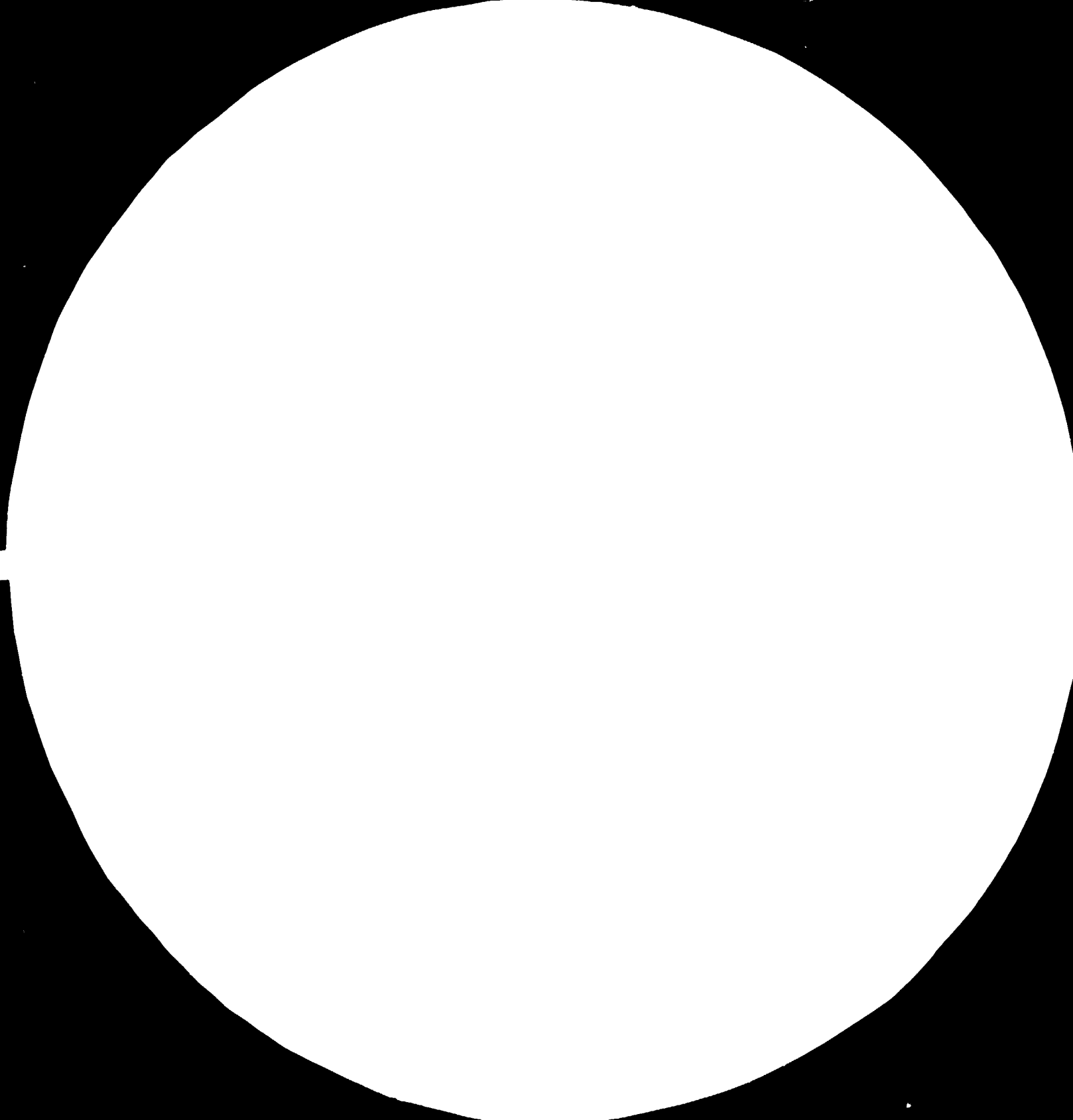
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MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

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13070

DP/ID/SER.B/ 425  
28 October 1983  
English

Iraq.  
ASSISTANCE TO THE GLASS INDUSTRY.

DP/IRQ/78/011

IRAQ

Terminal Report\*

Prepared for the Government of Iraq  
by the United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

Based on the work of F. Allison  
UNIDO Mechanical Expert

United Nations Industrial Development Organization  
Vienna

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INTRODUCTION.

Ramadi Glass Factory produces a varying range of glass products, ranging from sheet window glass to hollow and tableware.

No. 1 Furnace has three machines in full production.

Position No. 1 a Japan built press machine is in operation.

Position No. 2 a Japan built type H 24 Bulb machine is in operation.

Position No. 3 a Japan built Press machine is in operation.

No. 2 Furnace has two machines in full operation.

Positions No's 1 & 2 are occupied by Japan built Press machines.

The Japan press machines are similar in construction to the Lynch M.D.P. Press machines.

No. 3 Furnace has two machines in full production.

Position No. 1 has an 'E' type H 28 machine in operation.

Position No. 2 has an M.D.P. Lynch press in operation.

No. 4 Furnace has three machines installed.

Position No. 1 has a 'D' type H 28 machine not in operative condition.

Position No. 2 has an 'E' type H 28 machine in operation.

Position No. 3 has a Lynch M.D.P. press machine in operation.

No. 5 Furnace has two machines in operation.

Position No. 1 & 2 have identical I.S. 6 single GOB machines in operation.

NOTE:- All production machines mentioned are fully automated.

SUMMARY.

1. The I.S. 6 section machines were, on arrival and are now in full production, requiring from time to time minimal maintenance stops. Some problems are had with small items of spare parts.

2. The Lynch M.D.P. Press machines on arrival were both operated and maintained by an English Contract Group. These machines were handed over to the Factory Personnel at the end of August, 1982. Spares were at a critical level and many stops were had at the time.

3. The Hartford 28 machines were in a very serious condition and had many frequent stops in the course of a week. Production quality was also very poor. Many breakdowns occurred within a very short period of completion of maintenance. Spare parts stock was also very critical and, because of frequent breakdowns the stocks were depleted at an alarmingly fast rate.

Little or no attention was given to the lubrication systems of these machines.

The older 'D' type H 28 machine has been used as a spare parts source for the two 'E' type H 28 machines.

4. The vacuum system for both these machines were in a very run down condition. Parts are not available because of the age of the pumps.

The pipe-work leaked and was badly maintained.

Ramadi Factory has now in operation one Japan built Toyo-H 24 Light Bulb making machine. This machine has been adapted to make tumblers of various designs and sizes.

Upon close inspection, it was found that a very high percentage of the ware produced has a fault that is classed, on the International Market, as a critically dangerous reject. Very sharp pieces of glass are adhered to the inside base of the tumblers, which can and do, become dislodged during use.

This fault was made known to the factory counterparts.

The Government counterparts have taken necessary steps to eliminate this problem.



WORK CARRIED OUT.

Daily inspections are carried out by the expert assisted by the respective counterparts.

During these inspections, assistance and guidance is given to counterparts covering the whole machine complex and the probability of impending mechanical failures.

Maintenance programmes are planned from the daily checks carried out by the expert. Instruction has been given as often as possible to individual counterparts on the system of daily checks in order to identify probable failures in the mechanical operation of the machine.

Several suggested check list papers have been proposed and adopted. These only cover a portion of the recommended levels first discussed with the Technical Director. It is hoped, when the check list system has been fully accepted, that it can be increased to cover all aspects of the machine and ancillary equipment.

Several maintenance programmes have been made covering both 'A' and 'B' class overhauls.

Many problems arose because of the lack of essential parts.

A maintenance chart has now been introduced for both H 28 and Eldered machines and was later introduced for Lynch Press and I.S. machines.

The chart plan covers 'A' 'B' and 'C' class overhauls and the recommended period of time these planned maintenance stops should take place.

The times have been carefully calculated to suit Ramadi conditions which are far from normal due to the excessive dust etc.,

When a programme has been put forward for any one of the machines, it is discussed with counterparts, then an action date is decided upon. Depending on the available parts and the time other parts can be manufactured in the Engineering Dept.,

Every part required, if available, is prepared before the planned stop.

This has effectively reduced the period of time the machine is stopped by as much as two days.

Two major overhauls have been carried out on both H 28 machines and Elderedts to bring them back to a reasonable operative condition.

Preparation for these overhauls were carried out with the assistance of counterparts.

On each occasion, extra time was allotted so that training of all personnel involved could be carried out at the same time.

Both these H 28 machines are now functioning well and production levels are higher than they have ever experienced.

Suggestions for modifications to the eldered burn-off machine vacuum set up were put forward, now a more simplified system is in operation. This effectively reduces the mechanic of the system and lends to a more efficient use of the vacuum.

Proposed spare parts list have been checked and many recommendations have been put forward on the actual quantities needed, it is a very difficult task because of the unknown quantities that are stocked and the recording sytem. The unnaturally rapid use of certain parts also agrevates the task.

Recommendations have been put forward to create a separate recording system by the respective maintenance departments. This would help create a good sound history for future reference and in turn highlight the parts frequently used to assist in future parts orders.

Many problems occured because of the lack of understanding of some of the assembly drawings, on each occasion of maintenance overalls of parts, step by step guidance is given so that the understanding of the assembly drawings can be digested by the maintenance crews.

Parts to be manufactured at the factory set with some problems because no specification drawings were available.

This is now being overcome because the expert has now made many drawings covering all specifications required including materials.

Regular instructions are given during disassembly and assembly of gear boxes (gear boxes are the most frequent cause of machine breakdown) mainly due to techniques used by the maintenance personnel and lack of correct quantities and sometimes wrong lubricants. The use of an arbour press has been introduced for the stripping down and the assembly of all bushes, bearings and seals etc.,

The introduction of metal shimming to achieve the correct end float and backlash clearances in all gears and pinions in the gear boxes.

Because of the limited experience of the operative personnel, training in techniques to producing good quality ware and identifying glass faults and pinpointing the causes, has been given on many occasions.

A treatise covering the fourteen most common defects has been compiled to help the personnel. This covers all causes and remedies.

Hydraulic and P.I.V. gear boxes have been dealt with covering fault finding and overhauls.

These were the main items covered on the press machines and can also be identified with the I.S. 6 machines.

The vacuum system in use for both H 28 machines was very poor and an estimated loss of between 50% and 60% of the ware produced was had.

An inspection was carried out and the pumps were only producing approximately 25% of their full capacity. The loss was aggravated by approximately 120 metres of pipework and 35 right-angle bends.

Suggestions for modifications to the Eldered burn-off machines vacuum set up were put forward, now a more simplified system is in operation. This effectively reduces the mechanics of the system and lends to a more efficient use of the vacuum.

Proposed spare parts list have been checked and many recommendations have been put forward on the actual quantities needed. It is a very difficult task because of the unknown quantities that are stocked and the recording system. The unnaturally rapid use of certain parts also aggravates the task.

Recommendations have been put forward to create a separate recording system by the respective maintenance departments. This would help create a good sound history for future reference and in turn highlight the parts frequently used to assist in future parts orders.

Many problems occurred because of the lack of understanding of some assembly drawings. On each occasion of maintenance overhauls of parts, step by step guidance is given so that the understanding of the assembly drawings can be digested by the maintenance crews.

Parts to be manufactured at the factory met with some problems because no specification drawings were available.

This is now being overcome because the expert has now made many drawings covering all specifications required, including materials.

At present, the parts made on plant have a limited working life because of the sub-standard materials used. A list of precise materials have been put forward. If these are obtained along with the high standard of finished work produced by the Engineering Dept., the deficiency in the spare parts would be greatly relieved.

It would be beneficial to the factory to contact the lubricant suppliers and request that they send a lubricant expert to give advice on more suitable lubricants favourable to Ramadi conditions. On occasions, supply of Renite 'H' Blank Lubricant for the H. 28 machines run low, this can be solved if supplies of two oil based components can be obtained within the country.

The formula as follows, gives an equivalent lubricant to Renite 'H'.

50% Shell Carnea 21 oil  
50% Grafitic oil.

(Mixed together for 20 minutes).

The older 'D' type H 28 machine is not in operation and has been inspected by the expert. A complete list of parts needed to re-build and put the machine in production has been submitted to the Glass Company, on request.

Because of the enormity of the task and lack of adequate amenities and experience, it is recommended that the company contracts the re-build programme to an internationally known company, well experienced in servicing and overhauls.

Attached is an example of a check-list that is proposed to help in the maintenance of machine parts and to provide a history for future reference.

Because of the advancement in the training and acceptance at the latter stage of the experts project term. It would be unfortunate if the training of Iraqi counterparts ceased.

It would be beneficial if the government initiated a similar programme with an internationally known organisation.

RECOMMENDATIONS.

Daily checks by the Maintenance Department Chiefs must be made on their respective machines. This activity should be increased so as to involve other members of his crew.

The daily checks help to highlight frequent failures and speeds up preventative measures.

The introduction of a maintenance request system to involve the machine operating personnel over a 24 hour period would make known many problems that may not be noticed on the daily checks. This has been discussed at length with the counterparts and a format proposed.

The lubrication crews should carry out more regular inspections and record any excessive amounts of lubricants used in various points of the machine. Discussions have been had with the counterparts and a format for a logging system has been proposed and accepted.

The lubrication of the machines should be increased eventually to cover a 24 hour period. This means that the operative crews should share more of the responsibilities of the machine care.

Recommendations have been put forward on the points to be lubricated by the operative personnel and the time periods to carry out these duties.

Unless this or a similar system is adopted by the respective counterparts, then excessive periods of maintenance failures will continue and productivity will invariably be affected.

There is now completed at Ramadi, a very modern Technical Institute, with part of it's curriculum facilities enabling the teaching of all aspects of glass technology.

This would be beneficial if the factory and the institute started a programme of close co-operation. Contacts could be made with foreign glass company's to set out training programmes and to lend assistance in teaching and lectures. Thereby utilising the facilities for training factory personnel connected with the production of glass and in engineering.



Some of the counterparts selected by the company were not Iraqi, and left the company after a few months.

This caused some problems in the training of personnel.

Most of the operating personnel were not Iraqi. This caused many frequent problems during the training and supervising of the work by the maintenance crews.

Many of the foreigners did not follow the same lines as the Iraqi counterparts and caused numerous confusions during training and maintenance programmes set out with the expert.

Many of the experts planned project programmes were effectively terminated due to the situation.

JOB DESCRIPTION.

POST TITLE.

Expert in Mechanical Maintenance of H 28 machines and Lynch Presses.

DURATION.

6 months starting July, 1982.

QUALIFICATIONS.

Graduate Engineer with good experience of H 28 machines and Lynch Presses.

DUTIES.

The Expert will be a member of a team under the supervision of the Team Leader. He will be attached to the Head of the Maintenance Department and will be expected to carry out the following activities:-

1. Prepare maintenance programmes and assist in their application.
2. Assist in identifying mechanical faults or difficulties and give guidance in rectifying these faults and overcoming these difficulties.
3. Give guidance in mechanical repair work.
4. Assist in determining the spare parts needed for the machines as well as in determining the minimum and maximum requirements for storage.
5. Forming and training a team for the repair and mechanical maintenance of the machines.

JOB DESCRIPTION.

POST TITLE.

Expert in Mechanical Maintenance of I.S. Machines.

DURATION.

6 months starting January, 1983.

QUALIFICATIONS.

Graduate Engineer with long experience in mechanical maintenance and operation of I.S. machines.

DUTIES.

The Expert will be a member of a team under the supervision of the Team Leader. He will be attached to the Head of the Maintenance Department and will be expected to carry out the following activities:-

1. Prepare maintenance programmes and assist in their application.
2. Assist in identifying mechanical faults or difficulties and give guidance in rectifying these faults and overcome these difficulties.
3. Give guidance in mechanical repair work.
4. Assist in determining the spare parts needed for the machines as well as in determining the minimum and maximum requirements for storage.
5. Forming and training a team for the repair and mechanical maintenance of I.S. machines.

SEMI-ANNUAL REPORT.  
JULY 1982 - JAN: 1983

DP. IRC/78/001.

20.3.1983.

CONDITIONS ON ARRIVAL.

- A. After a general inspection, the I.S. machines appear to be in a good mechanical order, and the spare parts stock and system are good by comparison with other machines.

The Lynch Press machines on arrival were not a problem and production at a good level.

The Hartford 28 machine after inspection was found to be in a very poor condition, due, mainly to poor maintenance techniques and critical shortages of necessary parts.

DISCUSSIONS WITH COUNTERPARTS.

- B. Discussions were had with Mr. Hikmat, Sabeeh and Fathy to formulate a plan to combat the mechanical failures of the H 28 machines and decide on a spare parts priority.

PROGRESS.

- C. Progress has been made over many months and now the H 28 machines run almost continuously and production is at a level never before achieved.

The training of the maintenance crew is very slow, but positive.

ACTIVITIES.

- D. Now a chart plan is used for maintenance programming of the H 28 machines. It is hoped to introduce this system to programme the planned maintenance of Lynch Press and I.S. machines. This will also help to determine the quantity of spare parts needed over a 12 month cycle.

FUTURE WORK TO BE DONE.

- E. A programme has been formulated and discussed with Mr. Rakeb and Mr. Hekmat. This involves a programme of section re-building which will provide on the job training, maintenance history and planned maintenance. The maintenance history will help to determine the quantity of spare parts to be ordered and stocked in advance.

- F. This machine is in a very delapidated condition and many parts are missing.

I carried out a thorough inspection on this machine and in my opinion, this machine would be best overhauled by a company such as EMHART as no facilities are available to carry out such a re-build on plant.

I estimate, it could be a minimum of one year before this machine is put into production.

F. ALLISON.

UNIDO Expert.

20.3.1983.



QUALITY CONTROL. H 28 WARE DEFECTS.

From:- F. Allison.  
UNIDO Expert.

Date:- 2. 9. 1982.

Ware defects listed are the fourteen (14) most critical that are essential to control to meet competitive quality limits.

This group of defects usually comprise over 90% of reasons for failure to meet competitive quality limits.

Listed order does not represent their rank of severity or importance. However, there are some priority preferences that Production Management will require.

E.G. 'Cracks and Checks' are normally wholly unacceptable. To define some degree of occurrence or magnitude is a Management risk decision that would be based upon the probable failure of ware in service. Only Quality Control tests can safely define the risk factors. Comments are included to describe essential process control to reduce and control 'Cracks and Checks' to near elimination.

The fourteen (14) defects that will be dealt with in this treatise are listed as follows:-

1. Mold Rings.
2. Run Down.
3. Heel Tap.
4. Fine Glass.
5. Blank Tears.
6. Twist.
7. Washboard.
8. Crizzle.
9. Tear Drop.
10. Bead Size Control.
11. Blistered Bead (Burnt top).
12. Cracks and Checks.
13. Wall Thickness Variance.
14. Finished Ware Height Variance.

Source cause and corrective comments covering usual process control are made for each of the above defects.

1. Mold Rings.

Uneven mold cavity surfaces that contact the soft glass as it is blown cause channels, or ridges in the rotating article.

- a. Mold cavities must be smooth and round.
- b. Paste must be applied evenly and baked onto mold cavity evenly.
- c. Vents must be clean and smooth, free of ridges or raised spots.
- d. Pasted cavities must be free of any hard particles or foreign matter that protrude above the smooth pasted surface.
- e. Good cavity wetting each cycle is essential to produce consistent ware surface.
- f. The new paste facilities are presently being used to process and prepare paste molds. Controlled tests have demonstrated that 'Mold Rings' from these molds.
- g. Saw-slotted molds warp out-of-round --- tests showed very severe 'Mold Rings' from these molds.
- h. Hand rub-out of paste molds after baking and vent cleaning was found to improve surface smoothness.
- i. Service life of molds prepared, according to the above points averaged 8 to 12 hours of operation.

2. Run Down.

- a. When the sham surface temperature of the ware is above the glass softening temperature or it re-heats to above softening temperature, after release from Neck Ring at Take-out, the weight of the ware will cause 'Run Down' and related deformation.
- b. The outer skin of ware at sham level must be maintained at or below the glass softening temperature to avoid any 'Run Down'.
- c. The sure control is heat removal in the Forming machine. This insures the ware geometry will remain stable through all other subsequent processes.
- d. Special-accelerated heat removal must be achieved by operating each function of forming at it's optimum heat flow rate for the item of ware in process. Rates of heat flow can be varied for different items of ware (and they must) to produce best quality at the maximum controllable speed.



- e. The conventional H 28 machine is very limited in heat flow control. Additions and changes to the cooling systems adds the required capability to the H 28 machine to accelerate heat flow control for the production of a heavier ware.
- f. Fan air is very limited in pressure and velocity flow in confined areas. The H 28 machine (as is) possesses the original design limitations. In order to extend it's heat flow capacity, more compressed air is required where both pressure and velocity flow can be increased — with the symmetrical application to the mold equipment — within the present H 28 space and design restrictions.
- g. Heat removal is directly proportional to the effectiveness of cooling air flow.
- h. Small amounts of compressed air applied effeciently is adequate and effective and controllable with calibrated valves that can be re-set to a standard operation procedure.
- i. Adequate manifold air cooling along take-out conveyor is essential to prevent re-heat of sham surface to above the glass softening temperature.
- j. 'Run Down' will not occur when Forming machine cycle is operating within it's design control limits at the speed where ware geometry is in accordance with ware specifications, for shape quality. When these limits are exceeded, false economy prevails and ware quality variance becomes out-of-control.

3. Heel Tap.

- a. This defect can derive from only one cause, or from a combination of several causes.
- b. Proper gob loading is essential to insure gob is treated evenly thermally. If one side of gob is chilled during loading, more than other portions — 'Heel Tap' will be one resultant defect. Another will be poor wall variance control.
- c. Unevenly cooled plungers and blank molds (off centre) or more cooling applied to one side than to others will cause the Parison to 'banana' as it develops throwing the cold side against the blow mold as blowing takes place.
- d. Gob shape and uniform horizontal temperatures are essential to avoid pressing the blank with uneven thermal balance.
- e. 'Heel Tap' is most usually a direct result of non-symmetrical temperatures.

- f. Alignment of machine and delivery parts are necessary.
- g. Either heating or cooling one side of blank molds will cause 'Heel Tap'. The more of either used, the worse it becomes.
- h. Plunger cooling tubes off centre will also cause more cooling on one side of Parison when the blank is pressed. This effect has been shown by a large number of tests.
- i. Blank cavity design — ratio of diameter to height of pressed blank will permit 'Heel Tap' to develop more readily with less temperature difference in Parison. When the diameter is small in relation to height, the tendency for 'Heel Tap' is less.
- j. Also, the farther the glass must move during blowing to fill the mold cavity permits slight movement of Parison off centre (with very small temperature differences) to cause 'Heel Tap'.

#### 4. Fine Glass.

- a. The main cause of 'Fine Glass' on H 28 operation is poor Neck Ring assemblies, including 4 part rings and plunger, solid ring and blank mold condition and alignment.
- b. Neck Ring assemblies must be equipped with good springs of uniform strength from section to section. (Inconel '600' Springs are recommended for use).
- c. Four-part rings must close tight with smooth joint match lines when shut. When any glass can form between joints, the opening of the 4 - part ring will shatter the 'Fine Glass' many times causing cracked moiles.
- d. High standards of maintenance of neck ring assemblies and parison pressing equipment will eliminate the occurrence of 'Fine Glass'.

#### 5. Blank Tears.

- a. These defects — by their name — are many times misleading as to source cause.
- b. Neck Ring malfunction with blank mold during pressing and stripping can cause 'Blank Tears'.
- c. Neck Ring assemblies, if not maintained properly, will cause 'Blank Tears'.
- d. Poor blank cavities can cause blank tears. Poorly polished cavities can also cause this defect.
- e. Uneven heating and/or cooling will cause 'Blank Tears'. These sometimes appear as a lap in the glass.

6. Twist.

- a. Excessive blow pressure too early in blow cycle can cause body of ware to contact lower portion of blow mold first --- causing the 'twist' of the upper portion next to 'neck ring'.
- b. Cooling upper portion of Parison will assist on some ware. On others, cooling the lower portion allows the upper portion to contact mold simultaneously while initial blowing takes place. This will reduce the 'twist' effect.
- c. Paste mold wetting uniformly assist in control of 'twist'.
- d. Excessive speed with excessive blow pressure will cause 'twist'.

7. Washboard.

- a. Gob loading into blank mold is the usual cause of this defect.
- b. Condition of delivery equipment can contribute to 'Washboard'.
- c. Gob shape will influence the ease of delivery into blank mold without scuffing the gob of glass against the side of blank mold.
- d. Uniform gob temperature is necessary to allow proper control of gob delivery into blank mold.

8. Crizzle.

- a. Surface of glass will 'crizzle' when temperature differential between plunger surface or of blank mold surface is greater than the surface strength of the glass. Too rapid chilling on the surface causes the skin to check and crack or called 'crizzle'.
- b. Uneven mold temperatures can cause 'crizzle' in the colder portions.
- c. Excessive blank pressing pressure will cause 'crizzle'.
- d. Water from paste mold wetting when splashing into blank molds will cause 'crizzle'.
- e. Blank mold, or plunger shoulder operating at temperatures below 700° F. will cause 'crizzle'.

9. Tear Drop.

- a. The primary cause of 'Tear Drop' is allowing the moile while severing to hinge and wobble unevenly — pulling a heavy cord of glass at the last point of sever while burning off.
- b. Moile support and stretch control will nearly eliminate 'Tear Drop' on most ware items.
- c. Ware Wall thickness uniformity has important influence on even severing of moile with burner.
- d. Moiles of different diameters require the moile support to be adjusted to reduce hinging and wobble to a minimum.
- e. Driven-synchronized moile supports provide a superior process control; however, are much more costly — both to construct and maintain.
- f. Wall thickness variances that are under .012" can be controlled very successfully on present type moile support to reduce 'Tear Drop' to an acceptable competitive quality level.
- g. Burn-off machine adjustments should be designed to allow easy accurate adjustment of moile support while in operation to accommodate the ware's being produced.
- h. The edge finish quality will be directly related to the ware quality made in the H 28 machine. Inconsistent ware geometry will result in equally inconsistent edge finish quality. Unfortunately ware defects caused by these inconsistencies are recorded as 'Bad Burn-off'. Actually the best burn-off machine process would also produce the same results with the 'Bad' geometry ware.
- i. Many of the aforementioned forming process control functions result in affecting 'Tear Drop' control.

10. Bead Size Control.

- a. The burn-off machine process control assumes that reasonably consistent ware will be supplied to each burn-off machine head.
- b. When 'Bead Size Control' is practiced there are two basic requirements.
  - (1.) Control all burners with uniform intensity within practical tolerances — then time control of burner 'on' to sever and form bead must be automatically controlled by machine cycle. (This must be adjustable by the operators to suit the ware in process).

- (2). Time of ware in burner to sever and form bead can, also be accomplished by lifting ware from burner flame at the time bead size is at specified form.
- c. Beadless edge finish by burn-off requires very precise control of ware wall variance and of the above process operation.
- d. Bead size control requires that all burners be kept as clean as possible --- never more than 5% of ports plugged --- and no leakers. Individual adjustment of burners to be controllable within close tolerance of flame intensity --- each burner head must be capable of producing acceptable ware at all times to achieve the highest efficiencies.
- e. Overall machine regulation is recommended for best practice because of simplified process control. With this system, the head equipment that does not operate properly must be promptly replaced with good equipment. To continue to allow malfunctioning heads to operate is to voluntarily reduce operating efficiencies.
- f. The service use of ware by the customer frequently requires that edge strength of ware meet certain minimum standards. Tests by Quality Control can readily differentiate strength limits in terms of 'Bead Size'. The burn-off system can easily be adjusted to produce within these established quality standards by Process Control procedures by time and temperature of process.

11. (Burnt Top) Blistered Bead.

- a. The excessive intensity of flame with burn-off burners will re-boil glass causing break down of composition --- actually gasifying some components. This leaves the edge finish in a condition where the strength is greatly reduced and the appearance is not acceptable for marketing the article.
- b. Burn-off burners can be adjusted to a degree of flame intensity just below re-boil temperature --- the best burner performance is experienced at this level of operation.
- c. Some glass compositions re-boil more readily than others. Oxygen rich flame will cause re-boil on some glass --- while gas rich flame may cause re-boil on other glasses. With soda-lime glasses --- usually the re-boil is caused by separation of sodium in the glass, since it has a very low boiling point. White burner face deposits are evidence of condensed re-boil of soda-lime glass.

- d. Burner size vs. ware size vs. cracked gas-oxygen vs natural gas-oxygen are all very important relationships to take into account to control re-boil edge finish. Instructions have been given on these relationships to several burn-off operators. Each burn-off operators apprentice should be given formal training and instruction, with final examination demonstration to show his competence in adjustment and controlled setting of burner intensity.

## 12. Cracks and Checks.

- a. The source cause and methods of analytical identity of the derivation of cracks and checks can be grouped into some over-simplified descriptions.
- b. Almost every commercially manufactured glass article possesses some surface flaws. The physical character of these flaws determine the survival stability of the item through the process and it's performance in service use.
- c. Surface flaws are all subject to either mechanical damage or thermal shock - or both simultaneously.
- d. Mechanical damage is usually impact or pressure damage to the glass surface by handling equipment or by other ware in process. Whichever occurs, the resultant damage is usually fatal.
- e. Thermal shock damage can be and is usually varied in degree of occurrence influenced by the differential of temperatures that actually contact the glass surface to exceed the molecular strength of the glass. These are called thermal checks. These type checks are from microscopic size, up to fatal breakage of glass by cracks.
- f. Glass in process ranges in temperature from the near softening point down to room temperature. Temperatures between the softening point down to below the strain point of soda-lime glass are extremely vulnerable to local thermal shock of glass surface by contact, or by excessively chilled air flow over hot ware surfaces.
- g. Checks and cracks are avoided and prevented in process by insuring that hot ware surfaces are not exposed to thermal sock contacts, nor too chilled air sock drafts.
- h. All handling equipment surface contact areas must be smooth and either insulated or heated to a temperature that will not shock the hot glass surface beyond it's inherent surface strength. Surface strength varies with the degree of molecular compression prevailing on the glass surface contacted or exposed to shock.

- i. Glass production lines to reduce their vulnerability to checks and cracks must be as close coupled from feeder to lehr as physical space and working space will allow. Close coupling reduces the amount of uncontrollable exposure to temperature variables that interfere with process control of temperature environment.
- j. Most metal surfaces that must contact hot glass in process can be insulated by their coatings of graphite. This is only effective when metal surfaces are relatively smooth, and free from abrasive action on hot ware.
- k. Abraded or chipped surfaces of hot glass articles that are not re-glazed prior to annealing are vulnerable to fatal damage both from mechanical and thermal shock causes. Abraded or chipped articles that survive annealing are subject to reduced service life.

13. Wall Thickness Variance.

- a. Wall thickness variance source cause derives from several factors. However, by far the most important of the causes is thermal balance of temperature peripherally in plungers and blank molds.
- b. Gob loading does effect wall variance. Proper on-centre loading is desired. Gob must not be loaded against one side of blank mold to cause excessive chilling of one side of blank.
- c. The gob shape and it's thermal balance as it is sheared are very important to good wall thickness control.
- d. Symmetrical heating and/or cooling of plungers and blank molds are essential to produce the minimum wall variance.
- e. Plunger cooling nozzles must be accurately centred in the cooling cavity and the plunger exterior and interior surfaces must be very accurately concentric.
- f. Blank molds must be equipped to control cooling or heating 360° uniformly to provide a balanced horizontal thermal operating condition.
- g. When all sections of the H 28 machine are equipped in the above described manner, ware with very acceptable wall variance can be produced.
- h. Machine section alignment must be maintained within the established machine assembly and operating tolerances. When alignment fixtures are used to re-establish section accuracy, tolerances should be re-checked with specifications.

14. Finished Ware Height Variance.

- a. The source cause of ware height variance is one of the more obvious quality defects that can readily be corrected.
- b. H 28 machine sections are such that ware of uniform heights within  $\pm .015$  can be produced consistently from all sections. Mold hangers and neck ring assemblies and paste mold bottom plates can all be adjusted to within these limits.
- c. Quality Control limits however, have been lenient and allow  $\pm 1/32$  or  $\pm .031$  tolerance in finished ware height.
- d. Burn-off moile supports have been adjusted to accept up to .125" bottle height variance from H 28, which is extra lenient. It is preferable to adjust to .093".
- e. It has been found that burn-off spindles are individually adjusted from a common level to suit H 28 ware variance. This is a practice that has, in itself, encouraged the production of inconsistent ware on the H 28 machines. No other users of H 28 machines require burn-off machine spindle height adjustments to accommodate varying height of H 28 bottles.
- f. There is no way (only by guessing) that a burn-off machine operator can re-set spindles on the burn-off machine to accommodate ware whose geometry is erroneous because it was not made properly in the H 28 machine. This method of adjustment has no relationship to quality control specifications for ware height.
- g. When ware geometry is properly controlled in the H 28 machine, the burn-off spindles will not need adjusting.



