UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

17843

DP/ID/SER.A/1269
6 November 1989
ORIGINAL: ENGLISH

HIGH LEVEL CONSULTANCIES AND TRAINING

DP/SYR/86/009

SYRIAN ARAB REPUBLIC

# Technical report: Design and production facilities for sprinkling irrigation pipes*

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

Based on the work of S. C. Anand,
expert in pipe industry

Substantive officer: F. Chacon-Puig
Engineering Industries Branch

Backstopping officer: G. Anestis
Section for Integrated Industrial Projects

United Nations Industrial Development Organization
Vienna

31/.

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of the United Nations Industrial Development Organization (UNIDO). Mention of company names and commercial products does not imply the endorsement of UNIDO. This document has not been edited.

V.89 60908

## TABLE OF CONTENTS

INTRODUCTION

The consultant arrived Damascus on 7th June after briefing at Vienna and reported at UNDP. Damascus on 8th June 1989. He commenced his job at the main office of general organisation of engineering industries the same day.

Project authorities gave him necessary project documents of "Proposed Irrigation Pipe Plant Project". Project highlights were discussed for nearly a week and subsequently he was advised to concentrate on "Design and spare-parts Manufacturing Division" of general company of metal industries, with the objective of design of tooling (rools) for manufacture of irrigation pipes on the existing tube mill of general engg. company of iron and steel at Hamma.

Presently there are no existing production facilities for manufacture of Irrigation pipes or fittings except general workshop machines for manufacture of machine spares parts and moulds.

JOB DESCRIPTION (DP/SYR/86/009/11-02)

Brief job description as advised by Unido-Vienna is given below.

PURPOSE OF THE PROJECT

The project is aimed at assisting the government in strengthening existing facilities for sprinkling irrigation pipes and establishing an appropriate line for local manufacture of related equipment.

DUTIES OF CONSULTANT

- Fact finding/trouble shooting/identification of key problems of existing production facilities.
- Review of technical studies and technoeconomic assessment of most suitable production technology, for local manufacture of equipment.
- Preparation of programme for establishment of production line for irrigation pipes including infrastructural requirements, hardware, man power, training, timing needs and financial consequences.

PROJECT DURATION OF CONSULTANT

Four months in two split missions of two months each (both missions to be completed possibly during 1989).

ABSTRACT

General organisation of engg. industries has established nearly thirty factories to manufacture varities of equipment namely Iron and Steel, Steel Tubes, Cables, Electrical Motors, Televisions, Telecommunication equipment, Aluminium Prifiles etc. Presently apart from other projects, they are actively working on project to put up an integrated steel plant to manufacture one million tons of steel and other end-products.

The original project of irrigation pipe manufacture, by project authorities based on proposal of M/s Bauer of Austria, requires to be modified. It is strongly proposed to modify the proposal to manufacture irrigation pipes out of steel strip and subsequently galvanised inplace of pipes manufacture from aluminium strip.

Manufacturing cost of irrigation system made out of steel shall be nearly half to that of system made out of aluminium strip. Consultant has worked out detailed cost estimates of both steel and aluminium irrigation pipes (based on Bauer proposal) which prove the above statement of cost differential.

M/s Bauer of Austria who have submitted the existing proposal have the technology and know-how of steel irrigation pipes system as well and they should be asked to modify their proposal suitably.

However, presently government authorities are contemplating to manufacture sprinklers and quick coupling pipe fittings only in the spare parts manufacturing division of general company of metal industry and studying the

possibility of manufacture of irrigation pipes on existing tube mill of GECO STEEL (General Engineering Company of Iron and Steel).

Consultant, after the brief visit of GECO Steel Tube Plant, is of the opinion that steel irrigation pipes upto size 76 mm dia. can be conveniently produced on the existing plant provided necessary toolings (tube mill rolls) are procured for the same.

As required by project authorities, consultant gave required tooling design system and detailed calculations to enable GEEI design engineers to prepare detailed tube mill roll drawings and manufacture the same indigenously. In addition, engineers of design section have been given details of various kinds of quick coupling fittings required for irrigation pipes.

GEEI authorities have admitted the cost benefit of manufacture of steel irrigation pipes inplace of Aluminium irrigation pipes and also manufacture of these pipes, based on tooling design proposed by consultant on existing GECO-STEEL Tube Plant. Plain end pipes produced at GECO steel could be also galvanised on existing galvanising plant and pipe end fittings joined by glue; alternatively a new plant to be put up for galvanising ofpipes with welded end fittings.

Since steel irrigation pipes can be produced on existing HAMMA tube plant, project authorities have now set the target of manufacture of sprinkers and quick coupling fittings. To meet these requirements, revised job description- duly approved by G.E.E.I - of the second expert is enclosed on page no.33.

Meetings with ministry of agriculture or with F.A.O. authorities on different systems of irrigation could not be materialised.

## SUMMARY OF RECOMMENDATIONS

1. Since cost of manufacture of steel galvanised irrigation pipes is nearly half to that of Aluminium irrigation pipes, it is recommend to manufacture steel irrigation pipe system.

   - Steel end fittings can be easily resistance welded to steel pipe ends, without the use of Argon gas - which is also not available within the country.

2. Steel irrigation pipes of sizes 50 and 76 mm dia can be easily manufactured on existing GECO - STEEL HAMMA tube plant which is having ample idle capacity.

3. Instead of manufacture of five pipe diameters namely 50, 76, 102, 127 and 152 mm; pipe size range to be restricted to 76 mm, which would reduce variety of pipe fittings and make tube mill operations easy/smooth.

   - Requirement of 102, 127 and 152 mm dia pipes, which as per Bauer irrigation system accounts for only 30% of total pipe requirement, can be easily substituted by 50 and 76 mm. dia pipes by provision of additional pipe lengths/sprinklers.

4. For ease of tube mill production operations and decrease of pipe rejection, pipe sizes 102, 127 and 152 mm where Diameter - thickness ratio is more than 70, to be avoided.

5. To economise on material cost, proposed Bauer pipe thicknesses to be reduced and brought inline to that of prescribed in relevant DIN Spec. 19651.

6. In case project authorities decide to manufacture irrigation pipes on existing tube plant of GECO STEEL, the same to be studied in detail by the consultant to provide any modifications in the proposed roll pass design etc.

BROAD BAUER ALUMINIUM IRRIGATION PIPE PROJECT PARAMETERS

1. Annual pipe production - 1.5 Million meters
   - 1500 Kilometers.

2. Type of pipes
   Quick coupling thin wall aluminium pipes (as per Bauer HKA Aluminium coupling system)

3. Pipe size range (O.D.) in M.M. 50, 76, 102, 127 and 152.

4. Pipe length - 6 meter.

5. Areas that can be cultivated with Bauer system sprinklers= 23060 hactors.

6. Pipe réference specifications DIN 19651.

NOTES

i) Above production capacity is based on 300 working days/ year on one shift of 8 hours/day.

ii) Coupling materials to be manufactured indigenously:- quick coupling male and female, end cap, reducer, T piece and inlet T piece.
   Balance rest of components to be imported, i.e. sprinklers, $90^{o}$ bends, hydrant connection bend & T piece, support trap and trestle to riser pipe, lever closeure ring, rubber seal etc.

iii) Argon gas of 99.9% purity required for welding of cuplings to pipes to be imported by GEEI.

PROPOSED PIPE DIAMETER COMBINATIONS

Based on number of plots of different areas, as required by GEEI, M/s Bauer has proposed different pipe size combinations for main line and branch line including sprinkler spacing etc. which is summarised in table I and II .

TABLE - I

| S.No. | Plot Size Ha. | Sprinker spacing M. | No.of Plots | Pipe Size Combination main line dia x no. of pipes | Pipe Size Combination Branch line diaxno.of pipes |
|---|---|---|---|---|---|
| 1. | 5 | 12 x 18 | 1140 | 76 x 39 | 50 x 36 |
| 2. | 10 | 18 x 24 | 600 | 102 x 40 | 76 x 33 |
| 3 | 16 | 18 x 18 | 350 | 152x15 + 127x50 | 76 x 136 |
| 4 | 20 | 18 x 24 | 280 | 152x7 + 127x48 + 102 x 36 | 76 x 65 |

Total area of above plots that can be cultivated: - 23060 Hectors.

Pipe meterage required in different diameters and their % distribution.

TABLE - II

| Pipe Dia | Pipes in No. 6 M | Pipes in No. 3 M | Total pipe meterage | Distribution % |
|---|---|---|---|---|
| 50 | 41040 | - | 246240 | 16.4 |
| 76 | 131420 | 1440 | 792840 | 52.8 |
| 102 | 38400 | | 230400 | 15.3 |
| 127 | 31440 | | 188640 | 12.6 |
| 152 | 7360 | | 44160 | 2.0 |
| TOTAL | 249660 | 1440 | 1502280 | 100% |

PROPOSED PIPE DIAMETERS AND THICKNESSES BY BAUER - AUSTRIA.

It is observed that M/s Bauer has proposed in some sizes different pipe outside diameters and thicknesses incomparison to that of German standard for these pipes i.e. DIN 19651. It is clear from the following Table III (for Aluminium pipes)

TABLE - III

| German Standard DIN 19651 | | Bauer Proposal | | |
|---|---|---|---|---|
| (D) O.D. | (t) Thickness | O.D. | Thickness | D ÷ t Ratio |
| 50 | 1 | 50 | 1.2 | 41 |
| 70 | 1 | - | - | |
| - | - | 76 | 1.2 | 63 |
| 89 | 1.1 | - | - | |
| - | - | 102 | 1.2 | 85 |
| 108 | 1.15 | - | - | |
| - | - | 127 | 1.3 | 98 |
| - | - | 152 | 1.4 | 108 |
| 159 | 1.5 | | | |

COMMENTS

1. Bauer should follow outside dia. of pipes as close to DIN specifications as possible. It would facilitate ease in fitting pipes to that of pipes as per German standards. It would also provide flexibility in selection of different sources of procurement for fittings to be imported.

2 To save on material cost, M/s Bauer should reduce pipe thickness inline to that of German standards.

3. From percentage distribution table of different pipe diameters requirement, it is clear that combined pipe size requirement in dia. 50 and 76 mm accounts for 70% of total pipe length requirement.

4. To reduce variety in sizes of pipe fittings and pipes of different diameters; it is proposed to restrict pipe diameters to two or max. three only, i.e. 50 and 76 m/m which account for majority requirement. Demand of bigger diameter pipes can be substituted by providing additional pipes of dia. 50 and 76 mm and required sprinklers.

5. It would give rise to considerable saving in capital cost of tooling, since tube rolls for bigger dia. pipes cost exhorbitant. Not only there would be reduction in tooling cost; it would give longer production schedule of one pipe size, resulting in saving of roll change (tooling) time and reduction in rejection % i.e. initial rolling after tool change.

6. Further it is important to note that it is difficult to manufacture pipes having diameter ÷ thickness ratio of more than 70. By limiting production to lower two pipe diameters i.e. 50 and 76 mm where D/t ratio is less than 70, tube mill operations would become smooth and easy.

<u>Cost benefit analysis of aluminium verses steel galvanise pipes</u>

It is observed that German standard DIN 19651 ment for quick coupling irrigation pipes provides material of construction both aluminium and steel galvanised for irrigation pipes. Even M/s Bauer manufactures both kinds of above pipes. Infact their production of steel irrigation pipes is far more as compared to that of Al-irrigation pipes. In West - Germany, presently, nobody manufactures Al-irrigation pipes and it's demand is totally replaced by steel galvanised irrigation pipes.

Direct material cost alone, of Al-irrigation pipes is Observed to be double on present International prices of steel, aluminium and zinc as compared to that of steel galvanised irrigation pipes. Its costing detail are given below:-

COST COMPARISON BETWEEN ALUMINIUM AND STEEL IRRIGATION PIPES

Only direct material cost analysis has been made on present international prices, which is given below:-

PIPE WEIGHTS OF STEEL AND AL PIPES FROM BAUER CATALOGUE:-

| STEEL PIPES | | | ALUMINIUM PIPES | | |
|---|---|---|---|---|---|
| O.D. mm. | Pipe Wt. kg. | Total Wt. of 6m long pipe with coupling | O.D. mm | Pipe Wt. kg. | Total Wt.of 6mm long pipe with coupling |
| 50 | 5.64 | 6.3 | 50 | 3.04 | 3.54 |
| 76 | 9.21 | 10.8 | 76 | 4.59 | 5.84 |
| 89 | 11.51 | 13.7 | - | - | - |
| 102 | 14.85 | 17.3 | 102 | 6.19 | 8.15 |
| - | - | - | 127 | 8.34 | 12.03 |
| 108 | 15.45 | 18.6 | - | - | - |
| 133 | 21.05 | 25.9 | - | - | - |
| - | - | - | 152 | 10.77 | 15.63 |
| 159 | 27.33 | 33.9 | - | - | - |

Since 76 mm dia pipes requirement is of the order of 60%, necessary calculations are based on the assumption that the entire quantity of 1.5 million meters of pipe are made of this pipe size.

1. COST OF MATERIALS

Cost of Al, steel and zinc have been taken from metals-bulletin, London metal exchange prices and are average of last 6 months prices. (No latest prices were available with the GEEI personnel)

| | | |
|---|---|---|
| Cold rolled steel coil | = | 550 U.S.D./ton |
| Al coil cost | = | 4000 " " |
| Zinc cost | = | 3000 " " |
| Caustic soda (prices assumed) | = | 500 " " |
| Acid " | = | 400 " " |
| Flux " | = | 200 " " |
| Diesel " | = | 300 " " |

2. PIPE WEIGHTS

(taken from Bauer catalogue)

a) Al pipe 76 mm dia. 6 meter long without coupling = 4.59 kg

b) Steel pipe 76 mm dia 6 meter long without coupling = 9.21 kg

3. SCRAP AND REJECTION %

During the process of manufacture of pipes from strip, following percentage of scrap and rejection are observed:-

| | SLITTER | TUBE MILL | ASSEMBLY | PIPE GAL. | TOTAL |
|---|---|---|---|---|---|
| Al pipes | 2.5 | 3 | 3 | - | = 8.5 |
| Steel pipes | 2.5 | 2 | - | 1 | = 5.5 |

4. i) Effective cost of Al coils/ton including the cost of scrap/rejection = 4340 U.S.D./ton.

ii) Effective cost of steel coils including scrap etc. = 580 USD/ton.

5. Direct cost of Al and steel per pipe

i) Based on above material costs, direct cost of 76mm dia Al-pipe 6 meter - long, plan end
= pipeweight x cost /kg
= 4.59 x 4.34
= 19.92 U.S.D.

ii) Direct cost of steel pipe
= 9.21 x 0.581
= 5.34 U.S.D.

6. GALVANISING COST OF STEEL PIPE

Since steel pipes would have to be galvanised, its galvanising cost has been worked out as follows:-

Based on experience and standard practices, consumption of zinc and other galvanising chemicals is given below:-

| | | | |
|---|---|---|---|
| Zinc | = | 750 gms/sq meter of surface galvanised | |
| Acid | = | 20 kg/ton of material galvanised ie.2% | |
| Caustic Soda | = | 1 kg/ton " " " | = 0.1% |
| Flux | = | 5 kg/ton " " " | = 0.5% |
| Diesel | = | 60 lit/ton " " " | = 6% |

A) ZINC COST

In galvanising practice nearly 70% of zinc is picked up by pipe and the balance 30% is converted into by - products i.e. zinc ash, zinc dross and zinc blowings which can be easily sold off at minimum 50% of zinc cost.

Hence effective nett zinc cost per ton
= cost of zinc - selling price of bye products
= 3000 - 450 = 2550 U.S.D./ton.

Surface area of 76 mm dia pipe = 0.471 x 6
Zinc consumption/pipe
= 0.471 x 6 x 750
= 2120 gms
Zinc cost/pipe = 2.120 x 2.55
= 5.41/U.S.D.

b) <u>OTHER CHEMICALS COST</u>
Assuming 1.5 million meters (total production) of 76mm dia pipes of 6 meter length, total Wt of steel pipes to be galvanised (calculated) = 2300 tons.

i) Acid cost of galavanising 2300 tons @ 2%
Consumption = 23C˜ x 0.02 x 400
= 18400 U.S.D.

ii) Caustic soda cost = 2300 x 0.001 x 500
= 1150 U.S.D.

iii) Flux cost for pretreatment
= 2300 x 0.005 x 200
= 920 U.S.D.

iv) Diesel cost for galvanising furnace
= 2300 x 0.06 x 300
= 41400 U.S.D.

Total annual cost of galvanising
Chemicals = 18400 + 1150 + 920 + 41400
= 61870 U.S.D.
= 0.247 U.S.D./pipe

Total cost of galvanising materials
= cost of zinc + cost of chemicals
= 5.41 + 0.247
= 5.65 U.S.D./pipe

Grand total cost of steel pipe duly galvanised
= Cost of steel + cost of galvanising
= 5.34 + 5.65
= 10.99 say = 11 U.S.D./pipe

COST OF ALUMINIUM PIPE AS ALREADY CALCULATED UNDER SEC 5 - (i)= 19.92 U.S.D./PIPE

From above, it is clear that cost of direct materials for st-galvanised pipes is neary half to that of Al - pipes (without couplings). Secondly St. couplings can be easily resistance welded to pipes, without Argon gas requirement.

Advantages of steel galvanised irrigation pipes over aluminium-pipes.

| STEEL PIPES | ALU-PIPES |
|---|---|
| 1) Longer life - over 10 yrs. | 1) Lower life - Approx 5 yrs. |
| 2) Pipes donot dent easily during transportation | 2) Pipes being soft, get easily dented. |
| 3) Pipes can be easily welded at fields by OXY-acetylene gas, with normal skill. | 3) Pipes cannot be easily welded on site since Argon gas is reqd. In addition special welding skill reqd. |
| 4) During the process of manufacture couplings can be easily welded by electric resistance welding. | 4) Couplings can be welded to pipes by only special purpose M/CS, and by use of Argon gas or couplings can be glued to pipes. Both these methods are more expensive. |
| 5) Pipes can withstand higher pressures upto 20 Bar. | 5) Pipes can with-stand pressure only upto 12 Bar. |
| 6) For the same size pipe cost nearly half to that of Al-pipe. | 6) Pipe cost nearly double to that of steel pipe. |
| 7) Considering the same production meterage of million meters/year, inventory holding cost of steel+ zinc, less by nearly 1 million U.S. Dollars. | 7) Inventry holding cost of Al very high since it's cost/ton nearly 7 times to that of steel. |

## DISADVANTAGES

| STEEL PIPES | ALU-PIPES |
|---|---|
| 1) Steel pipes with fitting weigh nearly double to that of Al - pipes. | 1) Al pipes weigh nearly half to that of St. pipes. |
| 2) Initial capital equipment cost heigher, since additional plant for pipes and fittings galvanising required. | 2) Initial low capital equipment cost, since galvanising facilities not reqd. |

## IMPORTANT OBSERVATIONS ON MACHINERY OFFERED BY BAUER - AUSTRIA.

It is observed that no slitting line to cut wider coils to narrower widths required for individual pipe sizes has been provided. Hence only slitted material of reqd. widths would have to be procured for each and every pipe size. Its disadvantages are as under:-

i) Coil edges can get damaged during transit, resulting in heigher rejection percentage at tube mill.

ii) Coil edges get oxidised during long exposure to atmosphere and it becomes difficult to weld the same, it gives rise to greater scrap % during the process of welding.

iii) In case of use of wider coils, the same can be slitted to required widths required for different pipe size production since the same material can be used for pipe size 50 mm or 76 mm. It automatically results in reduction of raw material inventory.

iv) It is cheaper to procure wide coils and easier to procure wide coils and easier to handle them than narrower slitted strips.

DESIGN OF TUBE - MILL ROLLS FOR DIFFERENT PIPE-SIZES

As required by the Technical Director, I am giving below design system of tube mill rolls to enable the management to make steel irrigation pipes of any required diameter at tube mill of G.E.C.O. steel HAMMA. I am giving design system and detailed calculations of one pipe size i.e. 1" nominal bore.

Following steps are required for it:-

1. To know final tube diameter - outer to be manufactured.
2. To fix up diameter reduction in sizing section to arrive at dia at the welding rolls.
3. To calculate strip width.
4. To calculate arc length of strip at the central and lateral zones of forming section.
5. To assign curvature angles of central zone of forming section.
6. Calculation of section - Radious and roll width-of driven and idle passes.
7. Design of welding roll set.
8. Design of sizing roll set
9. Design of turkshead rolls

Strip formation into tubular shape is like flower petels and is clear from enclosed drawings, which also give necessary dimentions and their nomenclature.

EXAMPLE WITH DETAILED CALCULATIONS

BASIS

- Bottom line tube mill where tube bottom remains at the same level.

- Strip tension is maintained, which is essential for tube forming process-by increase of root dia. of bottom driven rolls by 0.2 mm from one pass to the next.
- In forming Sec.7 nos of driven horizontal stands and 6 Nos. of intermediate vertical stands considered.
- In sizing sec. 4 nos. of horizontal driven stands, 3 nos. of vertical idle stands and 2 sets of turkshead stands considered.

Strip during the process of conversion to tube is formed to tubular open section in the forming passes, welded by high frequency at the welding station (squeeze rolls), brought to exact dia. at the sizing section and strightened at the turkshead stand.

STEP I

Calculations considered for 1" nominal bore tube.

i) Pipe O.D. as per specifications

Max. - 34.2 mm
Min - 33.4 mm.

Mean diameter considered: 33.7 mm.

ii) Pipe thickness

There are four standard thicknesses in this dia:

Light 1 = 2.65 mm
Light 2 = 2.90 mm
Medium = 3.25 mm
Heavy = 4.05 mm.

iii) Based on experience, sizing allowance on different tube diameters is as follows:

| | |
|---|---|
| Tube size ½" to 1" | = 0.5 mm |
| Tube size 1¼" | = 0.6 mm |
| Tube size 1½" 2" | = 0.7 mm |
| Tube size 2½" | = 0.8 mm |
| Tube size 3" | = 0.9 mm |
| Tube size 4" | = 1.0 mm |

iv) Tube dia. at the welding zone=final tube O.D. + sizing allowance.

= 33.7 + 0.5 = 34.2 mm

STEP II

STRIP WIDTH CALCULATION

i) Strip width (S) = mean (theoratical) strip width at the welding station + welding allowance.

$$S = B + C$$

Value of $\pi$ = 3.14

ii) Mean dia. at the welding station is the neutral line which does not under go any deformation of stretch or contraction during forming process.

It is equal to = dia. at the weld point (-) Strip thickness.

$$B = DW - t$$

iii) Based on experience, weld squeezing allowance (C) is considered as follows:-

| | |
|---|---|
| For tube size ½" to 1" | = 1.5 t |
| " " " 1¼" | = 1.4 t |
| " " " 1½" | = 1.3 t |
| " " " 2" | = 1.8 t |
| " " " 3" | = 2.2 t |
| " " " 4" | = 1.05 t |

iv) Based on above, strip width for thickness
2.65 mm = 3.14 (DW-t) + 1.5 t
= 3.14 (34.2-2.65)+1.5 x 2.65
= 103.1 mm

Similarly strip width for thickness 2.9 = 102.7
" " " " " 3.25= 102.1
" " " " " 4.05= 100.8

v) We shall base our calculation on the average strip thickness and width.

$$\text{Average thickness} = \frac{2.65 + 2.9 + 3.25 + 4.05}{4} = 3.21$$

$$\text{Average Width} = \frac{103.1 + 102.7 + 102.1 + 100.8}{4}$$

$$= 102.17 \text{ mm}$$

STEP III

CALCULATION OF STRIP WIDTH AT THE CENTRAL AND LATERAL ZONES OF FORMING SECTION.

- Strip during the process of formation, is made tubular in 7 nos. of driven passes. Intermediate idle vertical passes donot allow strip spring back of formned strip and are not very critical.

- In the 1st pass strip is bent on either side of the strip, known as lateral zone to a radious equal to that of welding rolls and to $45^{\circ}$ angle.

- Each pass consists of central and lateral zone.

- Strip ARC length $= \dfrac{3.14 \text{ D x angle}}{360^{\circ}}$

i) Based on above, strip width at the lateral

$$\text{Zone} = \frac{2x\ 3.14\ (DW-t)\ x\ 45}{360}$$

$$= 2x\ 3.14\ (34.2 - 3.21)\ x \frac{45}{360}$$

$$= 24.33 \text{ mm}$$

ii) Therefore strip width at the central zone = average strip width - strip width of lateral zone

$$= 102.17 - 24.33$$

$$= 77.85\text{mm}$$

## STEP IV

## DETERMINATION OF ANGLES OF CUR-VATURE OF THE CENTRAL ZONE

- Out of 7 forming stands, three stands i.e. pass no. 7,6 and 5 have a central disc in the upper rolls. The purpose of this central disc is to guide the strip and avoid any twisting. This disc is known as "Fin".

- Thickness of fin varies depending upon pipe size and pass no. It is generally kept as follows:-

| DIA. | ½" | 3/4" | 1" | 1½" | 2" | 3" | 4" |
|---|---|---|---|---|---|---|---|
| 5th pass | 10 | 10 | 10 | 12 | 15 | 30 | 45 |
| 6th pass | 6 | 6 | 6 | 7 | 9 | 12 | 15 |
| 7th pass | 3 | 3 | 3 | 3 | 3 | 5 | 5 |

- Central angle of pipe is kept as 30$^{o}$ at first pass, and at the 7th pass strip section closes with a separation between the strip edges equal to fin thickness i.e. 3 mm for pipe size 1".

- Now we shall determine central angle at the 5th. Pass here roll perimeter is equal to average strip width + fin thickness. i.e. 102.17 + 10 = 112.17 mm.

- Knowing 112.17 mm covers $360^{o}$, angle of curvature of the central zone of 77.85 mm (calculated as under Sec.III-ii) will be

$$= \frac{77.85 \times 360}{112.17} = 250^{o}$$

- Angle of curvature at pass No.1 is kept as already stated above $30^{o}$ and is found to be $250^{o}$ at 5th. pass. For intermediate passes, it is devided proportionately such as given below:-

| | | | | |
|---|---|---|---|---|
| 1st | pass | central | angle | - $30^{o}$ |
| 2nd | " | " | " | - $85^{o}$ |
| 3rd | " | " | " | - $145^{o}$ |
| 4th | " | " | " | - $205^{o}$ |
| 5th | " | " | " | - $250^{o}$ |

STEP V:

CALCULATION OF ROLL PROFILE OF DRIVEN STANDS

PASS NO 1

I) Central angle - $30^{o}$

II) " zone Arc length = 77.85 mm

III) Mean radious of curvature

$$= \frac{77.85 \times 360}{2 \times 3.14 \times 30} = 148.75 \text{ mm}$$

IV) External radious of central zone

$$= 148.75 + \frac{\text{Mean thickness}}{2}$$

$$= 148.75 + \frac{3.21}{2} = 150.35 \text{ mm}$$

V) External radious of lateral zone (already calculated under sec I - IV; 34.2 ÷ 2 = 17.1 mm.

- Since pass No. 1, is most critical for strip edge breaking equal to weld pressure profile, we would like it to be formmed perfectly. Hence we would have 2 upper rolls for the same pipe size to cover 4 different thicknesses.

- 1 set of top roll to cover average thickness of 2.65, 2.9 and 3.25 mm 2nd set of top roll to cover thickness of 4.05 mm.

Average thickness of 1st. set = 2.93 mm.

a) Set 1 top roll central radious

= 150.35 - 2.93
= 147.42 mm

Set 1 top roll lateral radious

= 147.42 mm

Set 1 top roll lateral radious

= 17.1 - 2.93
= 14.17 mm

b) Set 2, top roll central radious

= 150.35 - 4.04
= 146.3 mm

Set 2 top roll lateral radious

= 17.1 - 4.05

= 13.05 mm.

VI) Width of upper roll = 2 sin $15^{o}$ (central radious - lateral radious) + 2 lateral radious.

= 2x 0.2588 x (147.42 - 14.17) + 2x 14.17

= 68.96 + 28.34 = 97.3 mm.

Similarly for average thickness of 4.05 mm upper roll calculated thickness is = 95.06 mm.

PASS NO. 2

- In the following passes, only central radious of curvature will be calculated since lateral zone bending is not done.
- For better, contact at the centre, we shall reduce the calculated central radious of upper roll by 2%.

i) Central zone angle (already established earlier) - $85^{o}$

ii) Mean radious at the central zone

$$= \frac{77.85 \times 360}{2 \times 3.14 \times 85} = 52.5 \text{ mm.}$$

iii) External radious or lower roll central radious=52.5+1.605

= 54.105mm

iv) Internal radious or upper roll Central radious

Central radious = 52.5 - 1.0605
= 50.895 mm

v) Actual upper roll central radious kept 2% lower (as already stated earlier)

= 50.895 x 0.98 = 49.9 mm

For pass No. 2 onwards, average thickness of 3.21 mm

kept since no lateral edge bending is required for strip.

PASS NO. 3 AND 4

Calculations for pass No.3 and 4 radii are done exactly in the same manner as that of pass No. 2 but with their predetermined central angle of curvature of $145^{o}$ and $205^{o}$ respectively.

The same duly calculated are as follows:-

PASS No. 3:

Lower roll radious = 32.282 mm
Upper roll radious = 28.6 mm

PASS NO 4:

Lower roll radious = 23.374 mm
Upper roll radious = 19.8 mm

Their calculations are as follows:

PASS NO. 3:

Central zone angle = $145^{o}$

Mean radious of central zone $= \dfrac{77.85 \times 360}{3.14 \times 2 \times 145}$

= 30.777 mm

Exterior radious or lower roll
Central radious = 30.777 + 1.605
= 32.282 mm

Interior radious or upper roll
Central radious = 30.777 - 1.605
= 29.172 mm

Actual upper roll radious being kept 2% lower
= 29.172 x 0.98
= 28.6 mm

PASS NO. 4:

Central zone angle = $205^{o}$

Mean radious = $\frac{77.85 \times 360}{3.14 \times 2 \times 205}$

= 21.769 mm

Exterior or lower roll radious = 21.769 + 1.605
= 23.374 mm

Interior or upper roll central radious = 21.769-1.605
= 20.164 mm

Actual upper roll radious (2% lower)=20.164 x 0.98
= 19.8 mm

Actual upper roll radious (2% lower) = 20.164x0.98

= 19.8 mm.

5th PASS:

For the calculation of 5th, 6th and 7th passes which have fin at the centre, we shall calculate the exterior radious of central section since rolls touch the external surface of strip only without any contact at the strip inner surface.

To avoid any scrapping of strip by the roll lateral surface, we shall increase the calculated radious by 2%.

Central angle = $250^{o}$

Mean radious = $\frac{77.85 \times 360}{3.14 \times 2x250}$ = 17.86 mm

Exterior radious = 17.86 + 1.605
= 19.465 mm

Actual roll radious (plus 2%)

= 19.465 x 1.02 = 19.9 mm

6th PASS

As already explained in Sec.IV, that the strip width + its fin thickness is equal to roll profile perimeter or its circumference, we shall calculate the roll profile on that basis. Perimeter of 6th pass = 102.17 + 6 i.e. Fin -

Fin - Thickness given in IV

= 108.7 m.m.m

Mean radious $= \frac{108.7}{3.14x2} = 17.22$ m.m.

External tube radious = 17.22 + 1.605 = 18.825 m.m.

Actual Roll radious (18.825 + 2%) = 19.2 m.m.

7th PASS

Similar to calculation of pass No.6 and knowing fin thickness of 3 m.m.

Perimeters of 7th pass shall be equal to
= 102.17 + 3 = 105.17

mean radious $= \frac{105.17}{3.14x2} = 16.74$ m.m.

External tube radious = 16.74 + 1.605 = 18.35 m.m.

Actual Roll profile radious + 2% = 18.7 m.m.

VI) Calculation of roll section of idler vertical rolls in between horizontal driven forming passes:

To avoid spring back of strip formed at the horizontal driven passes, intermediate vertical idle rolls are provided. These are not very essential.

Their profile is calculated by interpolation of former and later horizontal roll central angles.

Since these rolls cover only the strip external surface, only the exterior radious is calculated.

I) Vertical pass in between pass No.1 and 2 :

$$\text{Central Angle} = \frac{30 + 85}{2} = 57.5^{o} \text{ say } 58^{o}$$

$$\text{Mean radious} = \frac{77.85 \times 360}{3.14 \times 2 \text{x} 58} = 76.943 \text{ m.m.}$$

Exterior radious = 76.943 + 1.605 = 78.548 m.m.

II) Vertical pass inbetween pass No.2 and 3 :

$$\text{Central angle} = \frac{85 + 145}{2} = 115^{o}$$

$$\text{Mean radious} = \frac{77.85 \times 360}{3.14 \times 2 \times 115} = 38.806 \text{ m.m.}$$

Exterior radious = 38.806 + 1.605 = 40.41 m.m.

III) Vertical pass inbetween pass No.3 and 4 :

$$\text{Central Angle} = \frac{145 + 205}{2} = 175^{o}$$

$$\text{Mean radious} = \frac{77.85 \times 360}{3.14 \times 2 \times 175} = 25.501$$

Exterior radious = 25.501 + 1.605 = 27.1 m.m.

IV) Vertical pass in between pass No.4 and 5

$$\text{Central angle} = \frac{205 + 250}{2} = 227^{o} \text{ Say } 228^{o}$$

$$\text{Mean radious} = \frac{77.85 \times 360}{3.14 \times 2 \times 228} = 19.57 \text{ m.m.}$$

Exterior Radious = 19.57 + 1.605 = 21.175 m.m.

Actual Roll Radious (+2%) = 21.175 x 1.02 = 21.6 m.m.

V) Vertical pass inbetween pass No.5 and 6 :

$$\text{Mean radious} = \frac{102.17 + \left(\frac{10 + 6}{2}\right)}{3.14 \times 2} = 17.542$$

Exterior radious = 17.542 + 1.605 = 19.14 m.m.

Actual Roll Radious (+2%) = 19.5 m.m.

VI) Vertical pass inbetween pass No.6 and 7

$$\text{Mean radious} = \frac{102.17 + \frac{6 + 3}{2}}{3.14 \times 2} = 16.985 \text{ m.m.}$$

Exterior radious = 16.985 + 1.605 = 18.59 m.m.

Actual roll radious (+ 2%) = 18.59 x 1.02 = 18.9 m.m.

VII) Design of welding or squeeze rolls:

i) Diameter of tube at weld point has already been determined in sec-I(IV), which is equal to finished tube diameter + sizing allowance.
It is equal to 34.2 m.m. Therefore roll radious profile = 34.2 ÷ 2 = 17.1 m.m.

ii) Roll outer diameter should be kept as small as possible keeping in mind it's roller bearing and housing dimensions. XXX

iii) Gap between the two side roll flanges at the upper portion is kept between 1.5 to 2 times the max. strip thickness.XXX. The purpose of keeping lower outer diameter is to bring welding induction coil as close as possible to strip meeting point known as 'Apex', to achieve max. weld efficiency.

iv) Gap between the two side roll flanges at lower portion should be equal to max. stripthickness.

VIII) Design of roll sections of sizing group:

A - Horizontal stands / passes

I) Under section -I (III), sizing allowance for different tube diameters is already given and for tube diamter 1", 0.5mm has been fixed. It is proportionately divided into 4 nos of sizing stands and in turks head stands.

Final diameter of tube required: 33.7 m.m.
Diameter of tube at welding point = 34.2 m.m.
Hence external tube dia or roll profile
Diameters at Horizontal driven passes is kept
as under:

8th pass = 34.1 m.m.
9th pass = 34.0 m.m.
10th pass = 33.9 m.m.
11th pass = 33.8 m.m.

ii) Roll flange clearance between upper and lower rolls is kept between 1 and 2 m.m. (2 m.m. for rolls of bigger diameters and normaly 1 m.m. for Smaller diameters).

B. Vertical idler stands/passes

i) Roll profile (External) between pass No.8 and 9 = 34.05 m.m.
Roll profile (external) between pass no.9 and 10 = 33.95 m.m.
Roll profile (external) between pass no.10 and 11 = 33.85 m.m.

ii)Roll flange clearance between two side rolls is kept between 1 and 2 m.m. (Preferably 2 mm.)

IX) <u>Design of roll profile for turks-head stand</u>:

i) The purpose of rolls of turks head stand are basically for tube straightening. It's radious of profile is kept equal to that of finished tube size, which in case of 1" tube shall be 33.8 m.m.

ii) Gap between roll flanges is kept approx 1 m.m.

iii) Turks head rolls consist of 4 roll configeration which can be moved up and down individually or laterally. These can also be swiveled jointly.

Refer Annex.III and IV for strip formation and design drawing.

## NOTE ON LIST OF WORKSHOP MACHINES OF SPARE PART MANUFACTURING DIVISION (OF GENERAL COMPANIES OF METAL INDUSTRY)

There were found to be 36 machines in the said workshop. These machine were found to be spare in the different factories of general organisation of engineering industries, hence were brought under one roof with the idea of manufacture of necessary spare parts, moulds for plastic industry and for manufacture of spinklers etc.

These machines are of different makes, their upkeep not to standard and are not fully manned with necessary skilled man-power. Presently only 12 nos of operations are available for 36 machines. List of machines is enclosed in Annexure III.

## TRAINING ACTIVITIES

Formal training lectures on production technology for manufacture of aluminium and steel irrigation pipes including that of end fittings were conducting for their team of design engineers. Types of different end fittings available in the industry were apprised by means of assembly drawings and catalogues of different manufacturers.

In addition complete detailed design method along with calculations and drawings with detailed dimensions were prepared for possible manufacture of irrigation pipes on existing tube plant of Geco Steel Hamma .

ACKNOWLEDGEMENTS

Expert of his behalf and are behalf of Unido Anthorities acknowledge the cooperation and help extended by the following personnel to make necessary arrangements and to carry out the required study:-

1) GENERAL ORGANISATION FOR ENGINEERING INDUSTRIES:

1. Engg. M. AL - Mounajed - General Director
2. Engg. Antonios Sabbagh - Production Director
3. Engg. Sameer Sibbai - Technical Director
4. Dr.Abdul H. Dalati - Director of Scientific Economic Studies.
5. Engg.Wasfi Shammat - Civil Engg.
6. Engg. Ghattas Makhoul - Deputy Technical Director
7. Engg. Nabil Naamy - Designer
8. Engg. Aymen Altknin - Designer
9. Engg. Yasser Allam - Designer
10. Miss. Fadia Zeino - Secretary

2) GENERAL COMPANY OF METAL INDUSTRY

(Design and Spare - Parts manufacture Division)

1. Engg. Abdul Salam J. AL-DINE - Factory Manager
2. Engg. Osama Alakhras - Assistant Manager
3. Engg. Mohmoud Almorajed - Assistant Manager
4. Engg. Bashir Farhat
5. Engg. Fadwa Mekdad
6. Engg. Needaa Salhy

3) GENERAL ENGINEERING COMPANY OF IRON AND STEEL

1. Engg. Walid Asfar - General Director
2. Engg. Mustafa Shurbaie - Manager Pipe Factory

4) UNDP STAFF DAMASCUS

| | | |
|---|---|---|
| 1. | Mr.Khaled Alloush(Ph.D) | - Economist |
| 2. | Mrs.Nadia Kozak | - Senior Programme Assistant |
| 3. | Mrs.Nadia yazigi | - Administrative Assistant |
| 4. | Mr.Marwan Anhury | - Finance Officer |
| 5. | Mr.Omar Sheikn | - Administrative officer |

5) INDUSTRIAL TESTING RESEARCH CENTRE

| | | |
|---|---|---|
| 1. | Dr. Farouk Fawzi | - C.T.A. Industrial Quality Assurance Project (U.N.I.D.O. |
| 2. | Ms. Rafah Saheb | - Administrative Assistant Industrial Quality Assurance Project (UNIDO) |
| 3. | Mr.Ahmed Al-Ahdad | - Head of Non-destructive department (I.T.R.C.) |
| 4. | Mr. Ghyas - Keddeh | - Head of Mech. Testing dept. I.T.R.C.) |

REVISED JOB DESCRIPTION

DP/SYR/86/009/11-02/REV.2

| | |
|---|---|
| Post title | Sprinklers/quick couplings expert for irrigation pipes. |
| Duration | Two months (2m/m in 1989) |
| Date required | As soon as possible |
| Duty Station | Damascus, Syria |
| Purpose of the project | The project is aimed at assisting the government in strengthening existing design and production facilities for quick coupling irrigation pipe fittings and sprinklers and establishing workshop facilities for local manufacture of sprinklers and quick coupling fittings. |

Duties

The expert will be assigned to the General Establishment for Engineering Industries,GEEI, and delegated to the various production facilities in order to make a preliminary assessment of the situation in the production facilities in general and the shortcomings in hardware, operational routines and manpower in particular. The expert's activities related to quality control, quality assurance and problems of a troubleshooting nature will be performed in close cooperation with the respective national focal point namely the Industrial Testing & Research Centre (ITRC).

Specifically the expert duties will be as follows:

- To design sprinklers, quick couplings and related pipe and fittings for thin wall steel irrigation pipes.
- To design moulds, jigs and fixtures for manufacture of the same.
- To access existing workshop facilities and manpower available.
- Preparation of work programme for establishing of production line. for sprinklers and necessary quick coupling fittings for irrigation pipes, including manpower, training timing needs and financial consequences.

ANNEXURE-II

## WORKSHOP MACHINES AVAILABLE AT DESIGN AND SPARE PARTS MANUFACTURE DIVISION OF GENERAL COMPANY OF METAL INDUSTRY

| Sr.No. | Machine | Specifications | Quantity | General Condition |
|---|---|---|---|---|
| 1. | Central Lathe | Distance between centers X max. DIA | | |
| | | i) 400 x 200 | 1 | |
| | | ii) 1000 x 400 | 1 | Not very good |
| | | iii) 700 x 240 | 1 | |
| | | iv) 2000 x 700 | 1 | |
| | | v) 2000 x 500 | 2 | |
| | | vi) 1500 x 400 | 1 | |
| | | vii) 1000 x 400 | 1 = 8 nos. | |
| 2. | Automatic Turret | Distance between Centers | | Good |
| | | i) 42 | 1 | |
| | | ii) 36 | 1 = 2 nos. | |
| 3. | Electrical Furnace | Max. Temp. 1100 $C^{o}$<br>Size - 100 x 150 x 280 | 1 | Good |
| 4. | Vertical Drilling M/c | Max Drill size | | Not very good |
| | | i) 40 | 1 | |
| | | ii) 25 | 2 | |
| | | iii) 15 | 1 = 4 nos. | |



Contd...ii

| Sr.No. | Machine | Specifications | Quantity | General Condition |
|---|---|---|---|---|
| 5. | Radial Drilling M/c | Max Drill size 50 | 1 | Good |
| 6. | Sprak Erosion M/c | P = 13 KW | 1 | Good |
| 7. | Shaping Machine | P = 1.1 KW 2000 x 200 | 3 | Not very good |
| 8. | Planing Machine | 500 x 600 x 500 | 1 | Not very good |
| | | 200 x 300 x 350 | 1 | |
| | | 700 x 600 x 500 | 3 | |
| | | 200 x 500 x 450 | 1 | |
| | | 2000 x 1000 x 1000 | 1 | |
| 9. | Milling Machine | P = 7.3 KW 650 x 150 | 5 | Good |
| 10. | Pantograph | P = 250 Watt | | |
| | | Cutting rate = 400 x 300 | 1 | Good |
| 11. | Cyclindrical | 500 x 200 x 200 | 1 | Good |
| | grinding-machine | 1100 x 500 x 350 | 2 | |
| | TOTAL MACHINES | | 36 | |

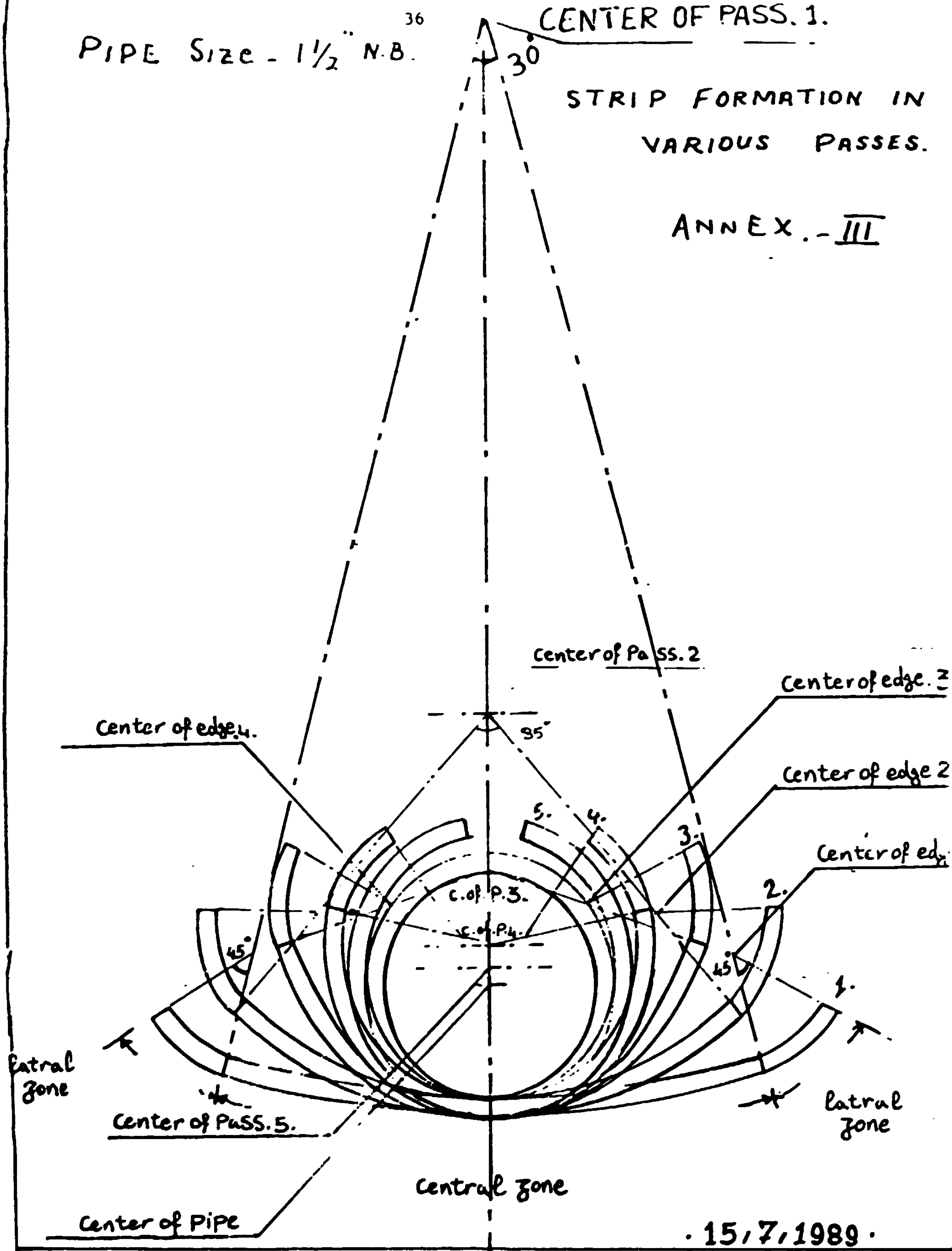
TOTAL OPERATIVE AVAILABLE = 12

TOTAL ENGINEERS AVAILABLE = 13

PIPE SIZE - 1½" N.B.

STRIP FORMATION IN VARIOUS PASSES.

ANNEX. - III




· 15/7/1989 ·

DESIGN By:
S.C. ANAND
UNIDO CONSULTANT

رسم
المهندس : ياسر اللحام
المؤسسة العامة للصناعات الهندسية والمكتب الهندسي

ANNEX IV

# VISIT TO INDUSTRIAL TESTING AND RESEARCH CENTRE - DAMASCUS

Consultant visited I.T.R.C. Damascus, sometimes to discuss problems related to steel tube manufacture and testing etc. It was observed that they are getting various kinds of problems from government agencies for material or product failure investigations.

I.T.R.C. is well equipped with necessary equipment and they have qualified/experienced personnel in physical and chemical analysis, however they do not have any qualified Metallurgist for metallography etc. It is recommended they should recruit Syrian metallurgist graduate engineers, send them for training abroad and UNDP should supplement it by deputing an expert/Metallurgist on metal failure analysis for duration of 2 to 4 months.

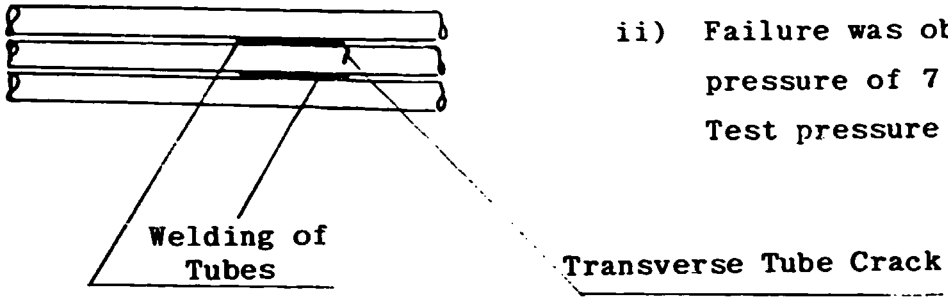
Some of the problems put to me, during my visit were as follows:

1. Failure of boiler tubes
2. Failure of built-up crank-shafts
3. Failure of drilling rods
4. Failure of cooling fan blades of turbine assembly.

## FAILURE OF BOILER TUBES

### TYPE OF TUBE FAILURE

i) Transverse crack on tube body was observed on row of tubes joined together by welding. These tubes duly welded with each-other were received from U.S.S.R.




ii) Failure was observed at pressure of 7 Atu against Test pressure of 20 Atu.

INVESTIGATIONS RECOMMENDED

1. Detailed chemical analysis
2. Yield strength, Tensile strength and elongation percentage of parent tube metal
3. Macro examination of tube cross-section
4. Hardness test of parent metal and of weldment
5. To determine tube specification no. and its technical parameters.

TECHNICAL PROPERTIES OBSERVED

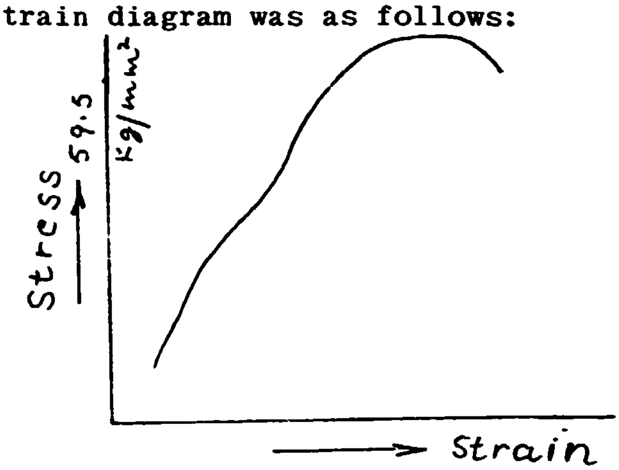
1. Chemical Composition

| | Limits as per spec. | | Observed | |
|---|---|---|---|---|
| | | | Base Metal | Weldment |
| C | 0.17 - 0.24 | | 0.22 | 0.24 |
| S | 0.04 | Max. | 0.016 | 0.016 |
| P | 0.04 | Max. | 0.008 | 0.008 |
| Mn | 0.35 - 0.65 | | 0.45 | 0.05 |
| Cr | 0.25 | Max. | - | - |
| Ni | - | | - | - |

2. Physical Properties

a) Tensile properties on Specimen size 3.1 x 8.125 = 59.5 kg/mm²

b) Yield point could not be observed as stress/ strain diagram was as follows:




c) Elongation - 26.6% on 30 mm guage length.

d) Hardness values (Brinell)

Load 187.5 Kp. Ball dia. 2.5 mm

| | | |
|---|---|---|
| Base Metal | - | 123, 121, 121 |
| Weldment | - | 103 |
| Heat Effected zone | - | 105 |

3. Specification No. - Russian CT-20.

4. Macro-examination of tube cross-section revealed uniforminity - indicating tubes are seamless and not welded.

5. Russian tube specification details were not available.

CONCLUSIONS/INFERENCE

1) Since Carbon equivalent of parent metal is observed to be 0.29 (calculated from formula $C\ Eq = C + \frac{Mn}{6} + \frac{Cr+Ni}{15}$) which is more than 0.2, and also temperatures in Russia during tube welding might be very low, it appears no preheating of tubes is carried at the time of welding.

These cracked tubes were cut off and replaced by syrian welders with usual precautions at Damascus Thermal Power Station and subsequently no tube failure was observed.

## FAILURE OF BUILT-UP CRANK-SHAFT

### TYPE OF FAILURE

To economise on foreign exchange for purchase of new crank shafts, presently worn out crank shaft journals are being welded to built up to its original outside diameter.

These crank shafts give life of only 200 to 300 hours before breakage at the web and journal joint.

### INVESTIGATIONS RECOMMENDED & CAUSES OF FAILURE

1. Type of electrodes used for built up were not known (These should be preferably low temp. electrodes).

2. No information was available on preheating and post treatment of journal welding operation. It is recommended that crankshaft web joints/journals are preheated and after weld built up, covered by asbestos rope to avoid any formation of martensite. Regarding preheating temperature and post heat-treatment, procedure given in A.S.T.M. hand book on welding and brazing was shown to them.

3. Failure of drilling rods

   It was observed that fresh supply of drillings rods were shearing off prematurely after use of nearly 300 hours. Chemical analysis and hardness results of previous good supply rods and of fresh supply of defective rods were found to be identical.

In the micro-analysis results fresh supply was found to have needle-like structure unlike that of previous supply. They were requested to send me micro-structure photo prints to enable me to reply them after consultation with metallurgists in India. (There appears to be heat treatment problem).

4. Failure of cooling fan blades

Cooling fan blades - during the equipment guarantee period - were found to be sheared off. These were said to be ment for cooling of turbine .end cover.

From the nature of fracture, it appears they had broken due to mechanical vibrations and striking with fan cover. They were asked to check about the same.

Persons Contacted

1. Dr. Farouk Fawzi C.T.A. Industrial Quality Assurance Project UNIDO.

2. Ms Rafah Saheb, Administrative Assistant, Ind. Quality Assurance Project UNIDO.

3. Mr. Ahmed Al-Ahdad - Head of Non Destruction Deptt. I.T.R.C.

4. Mr. Ghyas - Keddeh - Head of Mech. Testing Deptt. I.T.R.C.

In addition I met a team of other syrian engineers and experts.