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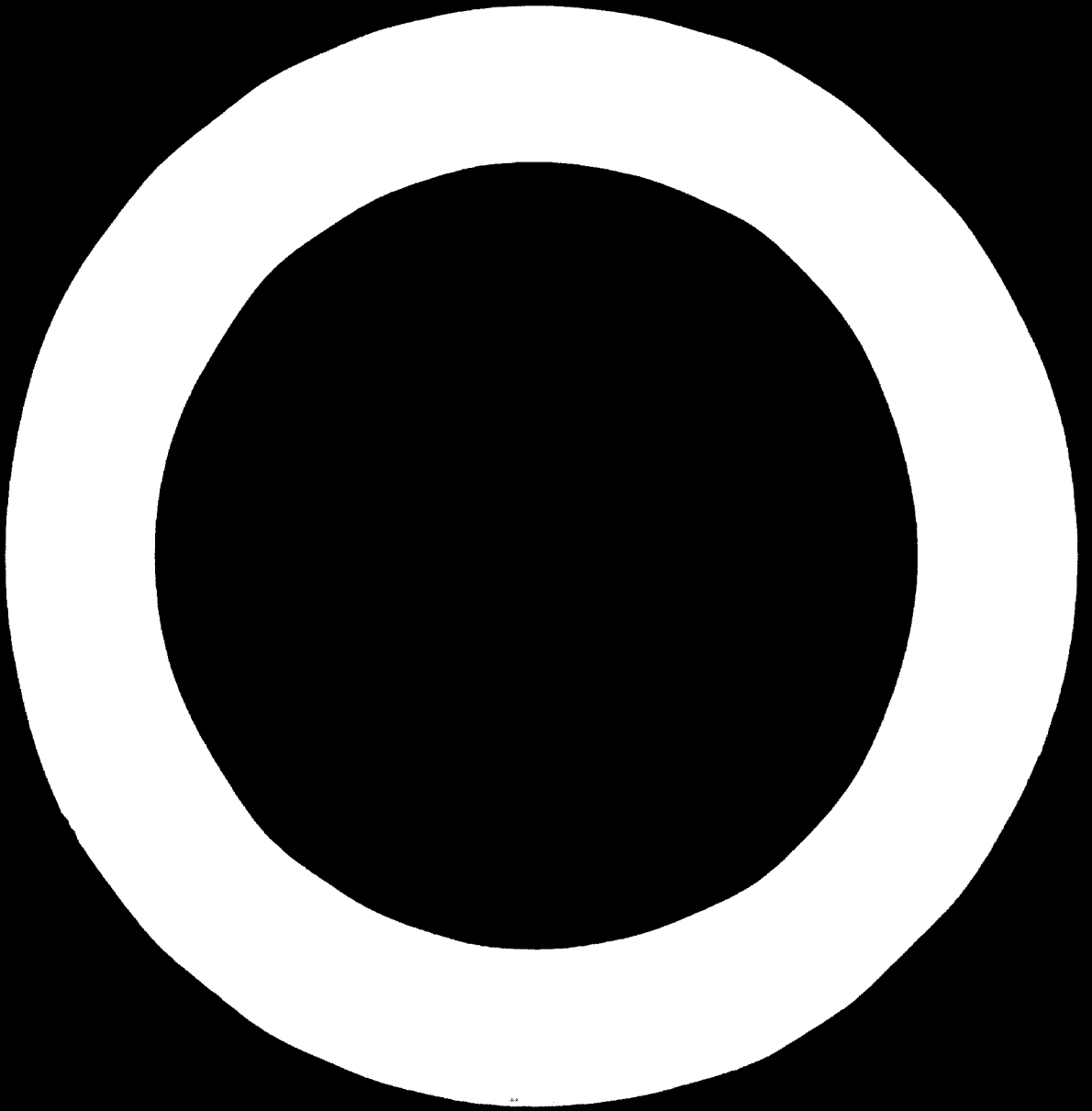
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United Nations Development Programme

ADVICE IN ENGINEERING AND PROCESS ENGINEERING  
FOR FERTILIZER PROJECTS, NEW DELHI

DE/IND/77/45

INDIA

Technical Report: High Pressure Plants

Prepared for the Government of India  
by the United Nations Industrial Development Organization,  
executing agency for the United Nations Development Programme

Based on the work of J. Nicholson, expert in high pressure plants

United Nations Industrial Development Organization  
Vienna, 1976

## **EXPLANATIONS**

Reference to "tons" (t) indicates metric tons.

Reference to "dollars" (\$) indicates United States dollars.

The monetary unit of India is the rupee (Rs). During the period of the project its mean value in relation to the United States dollar was \$1 = Rs8.25.

The following abbreviations are used in this report:

atm - atmosphere

EIL - Engineers India Limited

ICI - Imperial Chemical Industries

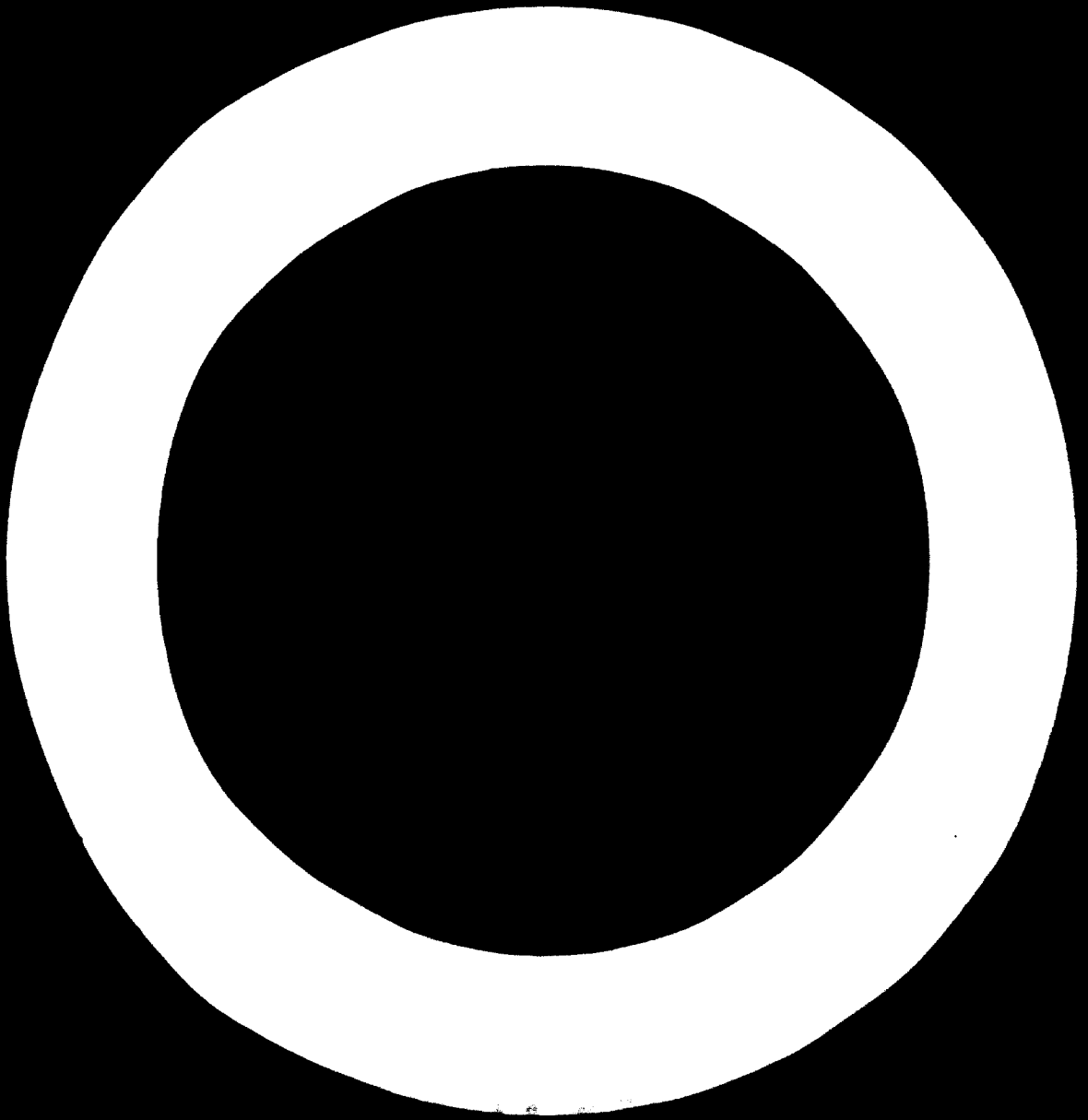
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## SUMMARY

In January 1974 the Government of India entered into agreement with the United Nations Development Programme (UNDP) for the provision of advice to Engineers India Limited (EIL) in connexion with the design and construction of urea fertilizer plants. The advice was to be provided by three experts, one for rotary machines, one for high pressure pipework, and one for the partial oxidation process.

The expert for high pressure pipework began his 12 month assignment on 9 December 1974 and terminated it on 5 December 1975.

The long-range objective of the project is to develop quickly Indian capability in the field of fertilizer manufacture from fuel oil using the partial oxidation process.

The immediate objectives are to obtain proper advice and guidance during the detail engineering phase of the fertilizer projects now in hand.

As regards the immediate objectives, in particular the design of high pressure pipework, it is the opinion of the expert that EIL now has sufficient information and expertise to design the essentials and to prepare standards for high pressure pipework including design of high temperature/pressure piping associated with gasification processes.

Greater safety in the operation of the ammonia and urea plants will be ensured by application of the safety policy changes to the process licensors plant and instrument diagrams as advocated by the expert. These changes included:

(a) Relief valves which protect low pressure equipment downstream of a pressure let-down of liquid from a high pressure source should be sized to cover abnormal conditions, such as failure of a let-down valve resulting in loss of liquid and breakthrough of the high pressure gas;

(b) Adequate isolation between a high pressure system and a low pressure system.

EIL were also advised to give particular attention to the installation in chemical plants of the correct materials.

A centralized piping design department, with a piping liaison officer attached to the relevant project sections, may give better results than those obtained by the task-force concept where the piping design draughting team is attached to the project section.

The process licensors of the fertilizer plants have provided EIL with advisory staff for the detail mechanical design of the pipework. The expert's help has not been utilized in this respect.

The junior design staff of EIL should be given the opportunity to obtain experience of plant construction and commissioning and to obtain knowledge of maintenance problems.

The efficiency of the Company's operation could undoubtedly be increased if the staff were housed in one building or nearer together.

## INTRODUCTION:

In January 1974 the Government of India entered into agreement with the United Nations Development Programme (UNDP) for the launching of a project, "Advice in Engineering and Process Engineering for Fertilizer Projects" (IND/73/045). The Government co-operating agency was the Ministry of Petroleum and Chemicals acting through Engineers India Limited (EIL). The executing agency was the United Nations Industrial Development Organization (UNIDO).

The advice was to be provided by three experts in (a) rotary equipment; (b) high pressure pipework as used in ammonia and urea plants; and (c) partial oxidation process for synthesis gas production.

The formal agreement was completed and signed on 11 January 1974. The project had been submitted in November 1973 and the proposed starting date was April 1974. The planned duration was 15 months.

The Government contribution was to be Rs 405,000 and the UNDP contribution was to be \$US92,000.

J. Nicholson, expert in high pressure pipework, was appointed on 7 December 1974 and on arrival in India was assigned to work with the EIL Piping Design Section.

P. Sen, manager of the Mechanical Engineering Design Section, was appointed as counterpart until June 1975 when K.D. Banerjee, head of Piping Task-Force Fertiliser Group, was appointed.

The objectives of the project were as follows:

(a) Long-range. To develop to the maximum extent and as rapidly as possible Indian engineering design and consultancy capability in the field of fertiliser manufacture from fuel oil, using partial oxidation processes based on the latest technology;

(b) Immediate. To obtain proper advice and guidance during the detail engineering phase of the three fertiliser projects in the following areas:

- (i) Proper selection and specification of critical rotary equipment such as compressors;
- (ii) Development of proper P & I diagrams for high-pressure pipework in ammonia and urea plants from the operations point of view;

- (iii) Proper selection, specification, and detailing of high-pressure equipment in ammonia and urea plants;
- (iv) Adoption of proper technology and choice of equipment for the recovery of carbon and its recycling through the partial oxidation reactor, with adequate disposal of un-recycled carbon as auxiliary fuel, or in the production of active carbon/ carbon black;
- (v) Checking on the basic design supplied by the various process licensors for these projects;
- (vi) Ensuring that proper amounts of stand-by equipment, spares, etc., are provided from an operational point of view.

EIL are contracted in association with the Toyo Engineering Corporation of Japan for the following fertilizer plants: at Bhatinda in the State of Punjab, commissioning date October 1977; and at Panipat in the State of Haryana, commissioning date February 1978.

The techno-economic feasibility study for the Government of India Fertilizer Project (Bhatinda), EIL Job No.0194, was completed in September 1973.

The feasibility study indicated a period of 30 months from the receipt of design data from licensor to mechanical completion.

These plants are each designed for the following outputs (ton/year):

Ammonia	297,000	(intermediate product) (technology by Haldor Topsoe)
Urea	511,500	(finished product as fertilizer) (by Toyo)
Sulphur	6,600	(by-product) (by Toyo)

The feedstock for the process will be heavy fuel oil. Coal will be used for steam generation in a separate boiler plant.

A brief description of the gasification, ammonia synthesis, and urea synthesis processes is given in annex I.

## I. FINDINGS

### III. PIPING DESIGN ORGANIZATION

During the expert's assignment EIL changed the organization of its piping design from a centralized piping design department to the task-force concept in which each project section has its own piping design and detail section. This organizational change disrupted for some time the collaboration with the piping design personnel. The expert's experience is that a centralized piping design section with a liaison piping designer attached to the project section gives better results. Possible reasons are:

- (a) More efficient use can be made of the high calibre piping engineers;
- (b) Greater manpower flexibility;
- (c) Demand for higher qualified personnel is reduced;
- (d) More incentives for promotion to higher grades within the piping sections;
- (e) Information and knowledge of piping work is centralized and more uniformly applied;
- (f) Closer liaison can develop with other functional sections, i.e., vessels and instrumentation.

### High Pressure Pipework for the Process and Area Plants

The detail mechanical design of the high pressure pipework was carried out by EIL in close collaboration with the advisory staff of the plant licensor, attached to EIL. The services of the expert were not utilized.

### Collaboration in Design

Specialist knowledge of other disciplines is not readily available and the collaboration normally associated with chemical plant design does not exist to the extent to be expected. The dispersal of staff in three buildings remote from each other militates against good collaboration.

### Action on Status of Design

Following the expert's written advice on the area plant P and I diagrams, there has been full collaboration between the process and operations staff and every effort has been made by them to implement his recommendations. One of the objectives of the project, development of proper P and I diagrams, has thereby to a considerable extent been fulfilled.

ADVICE PROVIDED

Advice was rendered to IIL personnel on the following subjects:

- (a) Fire testing of ball valves;
- (b) Installation in chemical plants of the correct materials as intended;
- (c) Establishment within the organization of an information section;
- (d) Guidance notes for IIL engineer visiting foreign contractors;
- (e) Piping section check-list;
- (f) Assessment of electric resistance welded tubings;
- (g) Review and comments on proposed manual for inspection and expediting;
- (h) Examination and comments with respect to drawings of steam piping;
- (i) Comments following examination of ammonia plant P and I diagrams;
- (j) Assessment of ball valve manufacturers' (Brenell and Rager) works and products;
- (k) Responsibilities of project piping personnel and preparation of design aid manuals;
- (l) Layout of pipework associated with a compressor unit;
- (m) Supporting of reboilers;
- (n) Supplier of high pressure valves;
- (o) Isolation of reformer catalyst tubes by slipping the transfer (pigtail) tubes (annex II);
- (p) Comments following examination of urea plant P and I diagrams;
- (q) Proposed action for preparation of high pressure piping standards;
- (r) Welding of alloys for high temperature duties;
- (s) Internal thermal insulation of vessels, furnaces and pipework;
- (t) Design of high temperature/pressure tubing associated with gasification processes (annex III);
- (u) Design of high pressure tubes and sketches of a particular standard submitted (annex IV).

Information concerning the following subjects was made available:

- (a) Control problems on steam reforming plants of large integrated ammonia plants with complex steam systems;
- (b) Vapouriser fouling problems;
- (c) Selection of materials to resist potassium salt corrosion in reformer gas boilers;
- (d) Performance of waste heat boilers in ammonia plants.

In addition, the expert was able to provide IIL with valuable information concerning the reliability of centrifugal pumps on urea plant emergency duty.

Additional Design Safeguards

The expert's most important advice dealt with recommendations relating to plant safety:

(a) It was suggested that in a pressure let-down system there should be no possibility of over-pressurization of the lower pressure equipment. For example, in the removal of the condensed ammonia from a high pressure synthetic loop system to a low pressure flash tank, the liquid ammonia is collected in a catchpot at high pressure (50 atm) and the level of ammonia liquid is controlled by level control system operation which allows the liquid ammonia to flow through a control valve to the low pressure flash vessel. From the flash vessel the liquid is flow-controlled to the storage vessel and the flashed ammonia gas is released under pressure control. The essential feature is that the flash vessel must have a relief valve to protect the vessel from over-pressurization and that this relief valve must be so sized as to take the full gas rate, should there be a failure of the level control system resulting in a complete loss of liquid ammonia from the high pressure catchpot and a gas breakthrough into the lower pressure flash vessel.

This design safeguard was brought to the attention of the plant licensors and it was later confirmed that the plant was safe in this respect.

(b) A number of instances were found of a high pressure system, (50 atm), being isolated from a low pressure system by a single high pressure valve. The risk here is that a leaking high pressure valve or maloperation of valves, i.e., closure of a downstream low pressure valve before the high pressure valve, could result in the over-pressurization of the lower pressure pipework. With the pressure differentials involved, failure of the low pressure equipment would be certain.

Following this advice, a change of specifications for certain pipelines and valves was being considered by EIL in collaboration with the plant licensors.

(c) It was stressed that extreme care is necessary to ensure the installation in chemical plants of the correct materials. In recent years a number of failures have occurred because of the mistaken installation of a wrong material, such as one plate of mild steel in a vessel which should have been completely of low alloy steel. The inspection requirements to meet this risk are considerable.

## II. RECOMMENDATIONS

To improve experience and knowledge within the Company, EIL should make every endeavour to give the younger staff experience of plant construction and commissioning and, if possible, the opportunity to visit operating plants for discussions with operating and maintenance personnel.

An essential factor in the design of modern chemical plants is the close collaboration of many disciplines. If it is to be fully effective in chemical engineering consultancy and design, EIL should take all necessary steps to institute specialist services and to ensure their full involvement and collaboration in all aspects of the Company's design and consultancy service. The safety of plants should receive particular attention as it seems that some process licensors are securing more economic initial plant-cost by the erosion of safety considerations.

EIL now possesses the information and expertise to formulate standards for high pressure piping for ammonia and urea synthesis plants. A task-force should be formed for the preparation of such standards and the associated specifications. The collaboration of metallurgists, stress analysis specialists, and other disciplines is necessary and their participation in this work should be ensured.

After a trial period of the task-force concept as applied to piping design, EIL should reconsider the organization of its piping design organization. This would be more effective if all sections could be housed in one building.

The Company should review their internal communications so as to keep the staff fully informed of all the aids and expertise available.

Possibly the present task-forces will develop into separate divisions of the Company, but this is to take a very long-term view.



## Annex I

### BRIEF DESCRIPTION OF PROCESS FOR UREA FERTILIZER PLANTS

#### General

The ammonia plant will have a capacity of 400 tons per stream day and the urea plant will have a capacity of 1,550 tons per stream day of prilled urea. The annual on-stream factor for each plant will be 330 days.

#### Gasification

Heavy petroleum fractions are gasified in a continuous non-catalytic partial oxidation reactor under pressure and waste heat is recovered as high pressure steam. The carbon produced in the reaction is separated in the form of homogeneous carbon-oil slurry. The major proportion of this carbon is recycled and the remainder is burnt and the heat recovered. Two-stage Rectisol process is used for desulphurization and decarbonization of the raw gas. The decarbonized gas is then treated in a nitrogen wash unit to reduce the CO and CO<sub>2</sub> content to traces.

#### Ammonia synthesis

The purified synthesis gas is compressed to 200 to 210 kg/cm<sup>2</sup> gauge pressure by a centrifugal gas compressor driven by a steam turbine.

The ammonia synthesis plant is of Haldor Topsoe design and uses their design of quench type ammonia synthesis converter.

The coupling joints used for the loop pipework are ASA 2500 lb with metal ring type gaskets.

#### Urea synthesis

The urea plant is designed by Toyo Engineering Corporation of Japan and produces prilled urea by the total recycle process using anhydrous liquid ammonia and by-product carbon-dioxide from the ammonia plant.

The synthesis section includes CO<sub>2</sub> compressor, liquid ammonia feed pumps, liquid ammonia preheater and a urea synthesis reactor.

The operating condition in the reactor is 250 kg/cm<sup>2</sup> gauge pressure at a temperature of 200°C.

The coupling joints for the urea synthesis loop pipework are a special Toyo trapped joint design.

APPENDIX II

**ISOLATION OF REFORMER CATALYST TUBE BY NIPPING  
OF THE TRANSFER (PIGTAIL) TUBES**

The object is to isolate a catalyst tube that has failed in some manner - either by the failure of a butt weld or a longitudinal split.

The failed tube has to be correctly identified and the exit and inlet pigtails nipped to stop the gas escaping from the tube into the furnace chambers:

It is imperative that a failed tube should be discovered as early as possible to avoid consequential damage to adjacent tubes or furnace walls by the flame from the damaged tube.

The failed tube must be correctly identified, otherwise the wrong tube may be isolated and ruined.

An absolute isolation is not always obtained, but almost always enough to enable the plant to be kept on stream without loss or further damage.

Identification of a failed tube

The following symptoms and action may assist in identifying a failed tube:

- Reduction in the gas exit temperature of the failed tube
- A sharp blue pencil of flame from the failure
- Local overheating of other tubes in the vicinity of the failure
- Incondensant brickwork adjacent to the failed tube
- A different noise level as picked up by ultrasonic leak detection equipment applied to the top flanges of the catalyst tubes
- Use of an infra-red camera to pick up the flame from the leak
- Appearance or change in the appearance of the failed tube
- Significant change in the length of the catalyst tube as compared with the other tubes and indicated by the position of the top or bottom flanges, depending upon the method of tube suspension

The process foreman should be responsible for the identification of the failed tube and should be assisted in this task by the duty or plant engineer.

Normal practice is to nip the bottom gas exit pigtail tubes first because nipping the inlet tubes first would reduce the gas flow and the tube temperature, making the nip harder to accomplish on the exit pigtail.

#### Inlet gas pigtail tubes

Inlet gas pigtail tubes are comparatively cool and their nipping is a fairly simple task. Essential is that the tube material will withstand the nipping operation without cracking. For this reason the tubes should be of a fairly ductile steel. Tubes of ordinary carbon steel are subject to cracking when nipped.

#### Exit gas pigtail tubes

A normal operating temperature for the tubes is about 650°C. The tubes must be in a nippable condition. That is, there must not be excessive carbonization and the diametral growth must be within set limits.

It is not possible to measure the carburization when the plant is on line. When the plant is shut down and cool, the degree of carburization may be measured by an "Elcometer". If it is assessed that the tube will be over-carburized before the next scheduled plant shut down, the pigtail tube should be replaced.

The diametral growth of the tube may be checked when the plant is operating at the time of catalyst tube failure. This may be done by means of a go no-go gauge.

The limit applied to Incoloy 800 tubes is a maximum diametral growth of  $2\frac{1}{2}$  to 3 per cent. A record should be kept of the initial outside diameter of each tube. If a tube at any time exceeds the allowable growth, it should be replaced.

#### Location of nip

If possible the tube should be nipped at a point which will leave space for a further nip, should the first nip be unsuccessful. Allowance for the second nip should be on the pressure side of the first nip; i.e. related to normal flow - inlet pigtail upstream - outlet pigtail downstream.

Degree of nip

The amount of nip may be determined by using wedge gauges to measure the distance between the clamp plates of the nipping tool.

Care must be taken to avoid shearing the tube completely.

A later design of tool for the nipping of close-spaced tubes which are in a hot environment has a stop incorporated to prevent over-nipping.

It should be noted that, according to ASTM B407, a 1 1/2" nom. bore Sch. 160 Incoloy 800 tube may have the following manufacturing tolerances:

	<u>Nominal</u>	<u>Maximum</u>	<u>Minimum</u>
Wall thickness	0.25	0.275	0.225
Tube outside diameter	1.60	1.67	1.65

Safety:

Under no circumstances should any attempt be made to bend pigtails which have been nipped.

The person delegated to examine the nip should have available a heat-resistant, air-cooled suit which should be worn if circumstances dictate.

General

ICI Agricultural Division Ltd has developed nipping tools which, together with a detailed description of the procedure, are available from them.

At the furnace design stage the number and location of the sight-holes provided in the furnace chamber casing need very careful consideration in relation to the identification of failed catalyst tubes.

### ANNEX III

#### THE DESIGN OF PIPES FOR HIGH TEMPERATURE/PRESSURE DUTY

##### Design Method

This design method has been used for the design of reformer catalyst tubes, hot gas exit pipes from the catalyst tubes, i.e. exit transfer or pigtail tubes, and of the gas-collecting manifold tubes. It can be applied to tubing required to operate in the creep stress range.

The main aspects to be considered in designing high temperature pipework is the strength in the creep range, resistance to degradation by the environment and the weldability of the material.

##### Strength factor

The strength factor usually adopted is the strength to rupture in 100,000 hours. This stress to rupture may be obtained from the data provided by the material manufacturer or from the calculated Larson-Miller parameter and the Larson-Miller diagram curve for the particular material.

The allowable safe design stress is then obtained by applying a suitable safety factor and the wall thickness calculated by the use of the mean diameter formula.

An extra thickness is allowed for carburization/oxidization if considered necessary.

The detailed procedure is as follows:

A. Obtain the stress to rupture in 100,000 hours

- (i) from the manufacturer's data, or
- (ii) calculate the Larson-Miller parameter from the formula

$$P = 10^{-3} \times T (C + \log_{10} H)$$

where P = Larson-Miller parameter

C = constant

T = minimum tube wall temperature (K)

H = design life in hours

For general use C = 15

and H = 100,000 hours

F. From the Larson-Miller diagram find the mean rupture stress ( $f_r$ ) relating to the parameter (P) calculated.

Note: Since the graph covers a range of readings for each parameter, the mean value of the curve is suggested and an over-all safety factor adopted for each duty as below.

G. Apply a safety factor to give the allowable design stress ( $f_s$ ) as follows:

Allowable design stress ( $f_s$ ) = rupture stress ( $f_r$ ) x safety factor. For the duties indicated the writer suggests the following safety factors:

- Reformer catalyst tubes 0.8
- Pigtail (transfer) tubes 0.8
- Henders or manifolds 0.6

D. Use the mean diameter formula to calculate the required wall thickness given the outside diameter of tubes

$$f_s = \frac{P (d_o - t)}{2t}$$

$$t = \frac{P d_o}{2 (f_s + 0.5p)}$$

given the inside diameter of tube

$$f_s = \frac{P (d_i + t)}{2t}$$

which gives

$$t = \frac{P d_i}{2 (f_s - 0.5p)}$$

where

- $f_s$  = allowable design stress
- $p$  = internal gas pressure
- $t$  = wall thickness
- $d_i$  = tube inside diameter
- $d_o$  = tube outside diameter

### Resistance to degradation

For reformer catalyst tubes and header manifolds an additional thickness should be added to allow for the carburization/oxidation, say 1/12 in. or 1/8 in. or 1/8 in. extra.

Note this calculation is based on the tangential stress due to the internal gas pressure. The tubes are generally supported so that the longitudinal stress is very low in comparison with the tangential stress.

In a reformer tube, degradation of the metal always begins on the process side and is initiated by carburization, i.e. diffusion into combination with the metal, giving a structure more readily oxidized by steam. Because of the carburisation oxidation effect, the practical operating limit for H K 40 material was considered to be about 960°C. Further operating experience may now indicate that this figure may be increased.

The practice in the writer's experience was that all spun cast reformer tubes were internally machined. With reference to ethylene furnaces an experimental furnace has confirmed that bore-machined tubes were much less affected by carburisation than as-cast bores.

The transfer tubes on many reformers are designed to take considerable differential thermal expansion between the catalyst tube and the gas collecting manifold. For this reason they may be long and bent to suit a particular shape so as to secure flexibility, access, and reasonable compactness. This explains the term "pigtail" tube used by some companies.

These transfer tubes require a fair amount of flexibility. If the policy of design and operation is to nip the transfer tube to isolate a catalyst tube, the transfer tube requires to be maintained in a nippable condition. This means that when the tube material has been carburized to a certain extent or diametrical growth has exceeded a pre-determined amount, the tube is replaced by a new tube. The transfer tubes therefore have a fairly short life and it is not necessary to add very much additional thickness, if any, to the tube wall thickness for carburisation/oxidation allowance.

### Weldability

The internal machining of the spun cast tubes removes the porosity in the surface metal of the cast bore. It also permits a more thorough examination of the casting material throughout the length of the tube. If porosity exists after the bore is machined to size, the acceptance of the tube is doubtful.

The tendency of catalyst to bridge across the tube and form empty pockets within catalyst-bed is also reduced if the tubes are bore-machined.

The information available to the writer indicated the following:

Alloys of the HP (25/35 Cr-Ni) type although more difficult to weld than HK 40 can be welded up to 1 in. in thickness. Alloys with higher alloy contents, like supertherm and MA-22-H, can be welded with difficulty up to 3/4 in. thickness. Thicker tubes may be unweldable. Information concerning welding should be sought before proceeding with the use of these alloys.

The information obtained from some tube-makers and engineering contractors should be treated with reserve. If possible, information should be obtained from plant operators. They are more likely to be able to give factual information about the material under service conditions. The information supplied by Henry Wiggins of the United Kingdom (Huntingdon Alloys of the United States) relating to Incoloy 800 stresses to rupture is an example of the data supplied by the manufacturers which may be used subject to the application of the requisite safety factor and possible carburization allowance.

With reference to reformer gas exit manifolds, the design should take cognizance of the multiplicity of branches for connecting transfer or pigtail tubes and ensure that the material removed for these branches is adequately compensated.

It is a wise precaution to provide excess metal in the manifold socket branches, to which the transfer tubes are welded, so that when replacement of the transfer tubes is necessary the carburized metal may be cut away leaving sufficient sound metal for welding requirements.

#### Sample calculation

The following calculation and diagram for 25/20 Cr-Ni are from "A time-temperature relationship to rupture and creep stresses" by F.B. Larson and J. Miller, Trans.ASME, July 1952, (page 765).

Reformer catalyst tube - material 25/20 Cr-Ni

A. (1) Information supplied:

Operating pressure - 300 lbs/in.<sup>2</sup>

Maximum tube wall temperature - 900°C

Design life - 100,000 hours

Internal diameter (machined) - 4 in.

Safety factor - 0.8      Carburization allowance - 1/8 in.



(11) Calculate Larson-Miller parameter (P):

$$P = 10^{-3} \times T (20 + \log_{10} t) \quad T = 900,273 = 1173 \text{ K}$$
$$= \frac{1173 (20 + 1)}{1000} \quad C\text{-constant} = 15$$
$$= 23.46 \quad R = 100,000$$

B. From Larson-Miller diagram

From P = 23.46 the rupture stress = 2200 lb/in<sup>2</sup>

C. Allowable design stress = 0.8 x 2200 = 1760 lb/in<sup>2</sup>

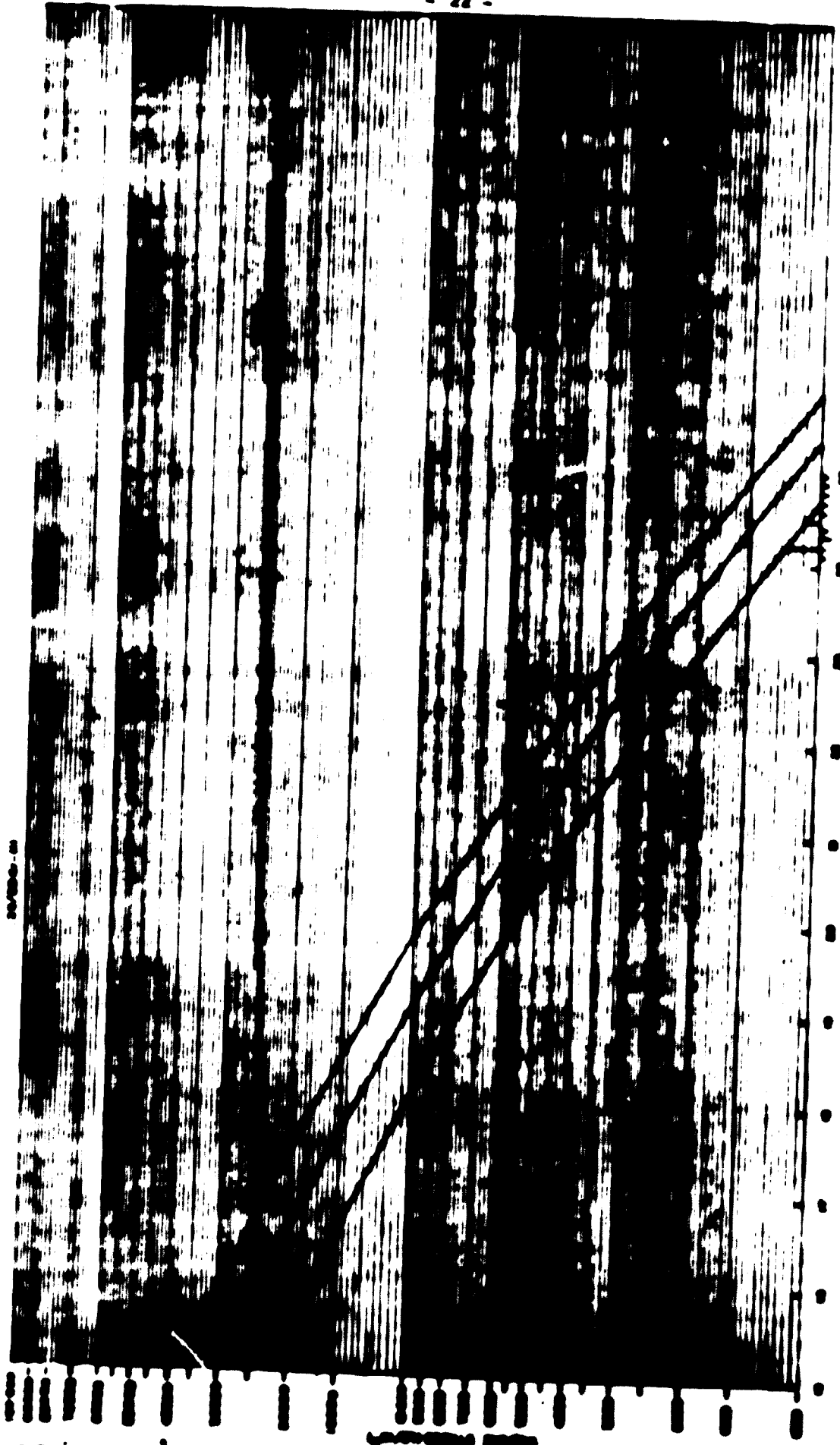
D. Wall thickness t =  $\frac{P \cdot d}{S (10 - 0.75)}$

$$t = \frac{100 \cdot 2.4}{1760 - 0.75 \cdot 1000}$$
$$= \frac{1000}{1760 - 750} = \frac{1000}{1010}$$
$$t = 0.378 \text{ in.}$$

Allowing for carburization

$$t = 0.378 + 0.125 = 0.503 \text{ in.}$$

A nominal wall thickness of 0.5 in. is therefore the minimum sound wall thickness for the tube as installed.



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## ANNEX II

### **STANDARDS FOR HIGH PRESSURE PIPING**

EIL do not possess piping standards for the high pressure pipework associated with the urea synthesis or the ammonia synthesis above the range of the American A.S.A. standards, but they have in their possession drawings supplied by licensors for urea synthesis plants. The pressure-temperature duty of the present stage ammonia plants use the 2,500 lb A.S.A. standards.

It was suggested to EIL that they should establish a small study group to consider general policy with regard to high pressure pipework standardisation and that the following points may be relevant:

- Assessment of the possible requirements of EIL
- Assessment of information available
- Consideration of the alternative designs
- Consideration of the economics of the various alternatives
- Evaluation of the previous operating experiences
- Decision on the pressure ranges to be standardised

Following the study group recommendations, assessment of priorities, preparation of worked programmes, and management approval, it was further suggested that a task-force should be formed to carry out the complete design and preparation of the standards and the associated specifications. The following aspects were given for consideration in the selection of the type of joint and coupling:

- Experience in similar duties
- Reliability of seal
- Safety - possible failure and extent
- Overall simplicity
- Resistance to temperature variations
- Required coupling bolt loading, i.e. bolt stress
- Required degree of skill to make joints
- Rate of renewing joints

- Acceptance of pipar misalignment
- Adoption for acceptance of fittings, such as orifice plates
- Welding requirements
- Availability of matching equipment, valves etc.
- Comparison of costs
- Avoidance of proliferation of standards
- Stores requirements
- Supplier indigenous to India
- Acceptability of mating flanges of dissimilar materials
- Height of joint assembly and corresponding tube
- Overall flexibility
- Lining up of flanges
- Required accessibility for a flanged joint
- Resistance to vibration
- Required accuracy of machining

The recommendation given verbally was to standardize the low ring type joint.

Determination of tube thickness

It was suggested that the design methods based on the last formulae be adopted as given in "High Pressure Engineering" by Hanning and Latrou. A copy of this book is in the IIL library. (Mr. S. Latrou was my colleague at Imperial Chemical Industries (ICI) in England and responsible for a great deal of the ICI Design (Stress) Manual.)

The following standards for high pressure pipework low ring joints and couplings were made available to IIL for their guidance and copies are attached (see appendix).

<u>Std. No.</u>	<u>Page</u>	<u>Description</u>	<u>Temp. (°C)</u>	<u>Temp. Range</u>
6050	2	Carbon steel flanged pipe joints 2 in. to 6 in. nom. bore	150 to 185	15° to 200°C
6055	2	Carbon steel flanged pipe joints with clearance for socket spacers 2 in. to 6 in. nom. bore	100	15° to 200°C
6060	2	Carbon steel flanged pipe joints connecting 3 per cent cr. steel hot pipeline to carbon steel pipeline (200° C max.) 2 in. to 5 in. nom. bore	180 to 215	-

<u>Item No.</u>	<u>Qty</u>	<u>Description</u>	<u>Price (1950)</u>	<u>Temp. Range</u>
6075	2	Carbon steel flanged pipe joints 1/16 in. to 1 in. nom. bore	410 to 570	35° to 200° C
6078	2	Carbon steel flanged pipe joints connecting 3 per cent cr. steel hot pipeline to carbon steel pipeline 200° C max. 1/8 in. to 5 in. nom. bore	410 to 435	
6090	2	Carbon steel flanged pipe joints with clearance for socket spigots 1/16 in. to 1/2 in. nom. bore	300	35° to 200° C
6115	2	Flanged pipe joints - 3 per cent cr. steel 1/16 in. to 5 in. nom. bore	-	300° C
6120	2	3 per cent cr. steel flanged pipe joints with clearance for socket spigots 1/16 in. to 5 in. nom. bore	-	300° C
6012	2	Pipe coupling secured carbon steel 1/16 in. to 1/4 in. nom. bore	495	200° C

These or similar standards have been used successfully over a period of many years for ammonia synthesis plant pipework.

The information now available to ILL is sufficient for them to prepare the required standards. It was emphasized that time and effort are required to standardize each range of pipework and associated equipment, such as valves and instruments. The collaboration of many disciplines is required.

Furthermore a copy of a catalogue of proprietary joint fittings (Grayloc) was handed to ILL. This type of joint ring in combination with A.S.A. flanges is now used by ILL. The benefit is that a Class 1,500 flange is used on a Class 2,500 duty and the bolt loading is quite low.

A copy was obtained from British Engines Ltd, of Newcastle upon Tyne, of its catalogue of high pressure valves and submitted to ILL with the suggestion that these valves could be used as one of their standards for high pressure equipment. Such valves are used by ILL for many high pressure applications.

# CARBON STEEL FLANGED PIPE JOINTS

20 TO 24 in. O.D. PIPE PRESSURE  
RANGE 27°C TO 27°C TEMPERATURE RANGE

IC REFERENCE  
**DB 6050**

PAGE 1 OF 1  
REVISED NO. 1 DATE 08 70  
BY 1000 NO. DATE

**GENERAL SPECIFICATIONS**

FORMERLY D-449

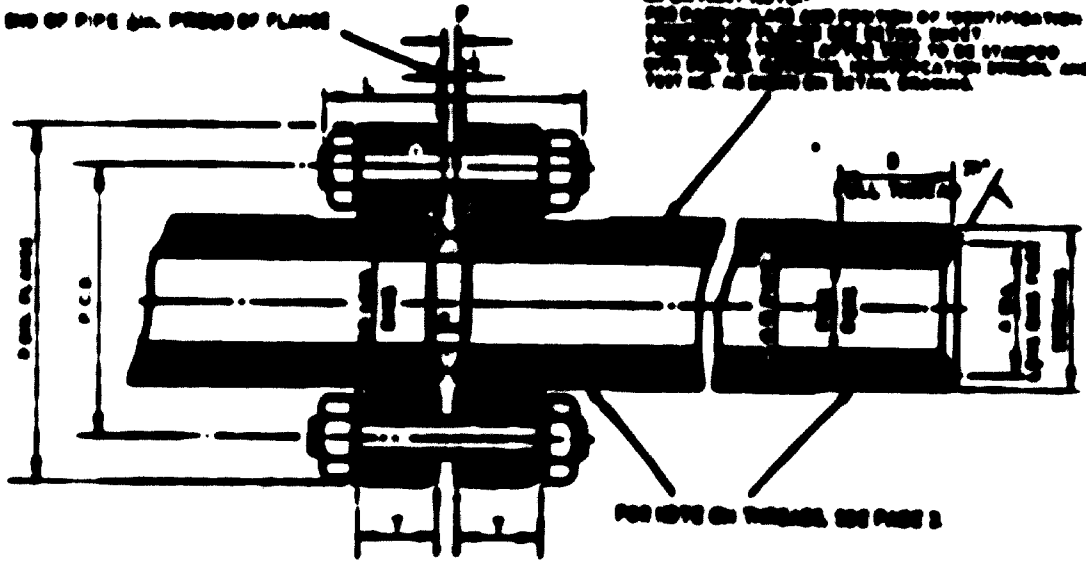
TYPE OF JOINT  
FLANGED  
STUB ENDS

AS PER  
AS PER  
AS PER

FOR DETAILS OF THE JOINT AND THE ATTACHMENT AND HYDRAULIC TEST PROCEDURES SEE PAGE 2

END OF PIPE (IN. FROM FLANGE)

**IMPORTANT NOTE:-**  
THE CENTERLINE AND LOCATION OF IDENTIFICATION MARKS ON THE END OF THE PIPE SHALL BE STAMPED FOR THE IDENTIFICATION MARKS AND FOR THE CENTERLINE OF THE FLANGE AND FOR THE CENTERLINE OF THE JOINT.



FOR DETAILS OF THE JOINT AND THE ATTACHMENT AND HYDRAULIC TEST PROCEDURES SEE PAGE 2

FOR DETAILS OF THE JOINT AND THE ATTACHMENT AND HYDRAULIC TEST PROCEDURES SEE PAGE 2

ALL DIMENSIONS IN INCHES

CARBON STEEL PIPE				CARBON STEEL FLANGE				STUB ENDS		JOINT		TEST PROCEDURES	
NO.	QTY.	SIZE	TYPE	NO.	QTY.	SIZE	TYPE	NO.	QTY.	NO.	QTY.	NO.	QTY.
1	1	24"	AS PER	1	1	24"	AS PER	1	1	1	1	1	1
2	1	24"	AS PER	2	1	24"	AS PER	2	1	2	1	2	1
3	1	24"	AS PER	3	1	24"	AS PER	3	1	3	1	3	1
4	1	24"	AS PER	4	1	24"	AS PER	4	1	4	1	4	1
5	1	24"	AS PER	5	1	24"	AS PER	5	1	5	1	5	1
6	1	24"	AS PER	6	1	24"	AS PER	6	1	6	1	6	1
7	1	24"	AS PER	7	1	24"	AS PER	7	1	7	1	7	1
8	1	24"	AS PER	8	1	24"	AS PER	8	1	8	1	8	1
9	1	24"	AS PER	9	1	24"	AS PER	9	1	9	1	9	1
10	1	24"	AS PER	10	1	24"	AS PER	10	1	10	1	10	1

NO. OF SHEETS	
<b>DB</b>	<b>6050</b>
FILE NO.	OF
BY SHEET NO.	DATE
BY SHEET NO.	DATE

NOTE: THESE - FOR GENERAL USE ONLY TO BE  
 MAINTAINED, THESE SHOULD BE KEPT  
 TO S.O.C. UNIT'S GENERAL CLASS  
 GROUP TO S.O.C.S.  
 ALL STRUCTURES IN THIS

NO.	SHEETS		
	TYPE		PLANS
	PLAN	NO./REV DATE	
1	PLAN	000/00	0000/00
2	PLAN	000/01	0000/01
3	PLAN	000/02	0000/02
4	PLAN	000/03	0000/03
5	PLAN	000/04	0000/04
6	PLAN	000/05	0000/05

NO.	SHEETS			REVISION NO./DATE
	TYPE NO./REV	NO./REV	NO./REV	
1	PLAN	000/00	0000/00	000
2	PLAN	000/01	0000/01	000
3	PLAN	000/02	0000/02	000
4	PLAN	000/03	0000/03	000
5	PLAN	000/04	0000/04	000
6	PLAN	000/05	0000/05	000

# CARBON STEEL FLANGED PIPE JOINTS

5/16" CLEARANCE FOR SOCKET SPINDERS  
3000 PSI DESIGN PRESSURE  
GRADE 30°E TO 700°E TEMPERATURE RANGE  
7/16 TO 8/16 O.D. END END SIZES

NO. REFERENCE	
<b>DB</b>	<b>6055</b>
PAGE 1	OF 2
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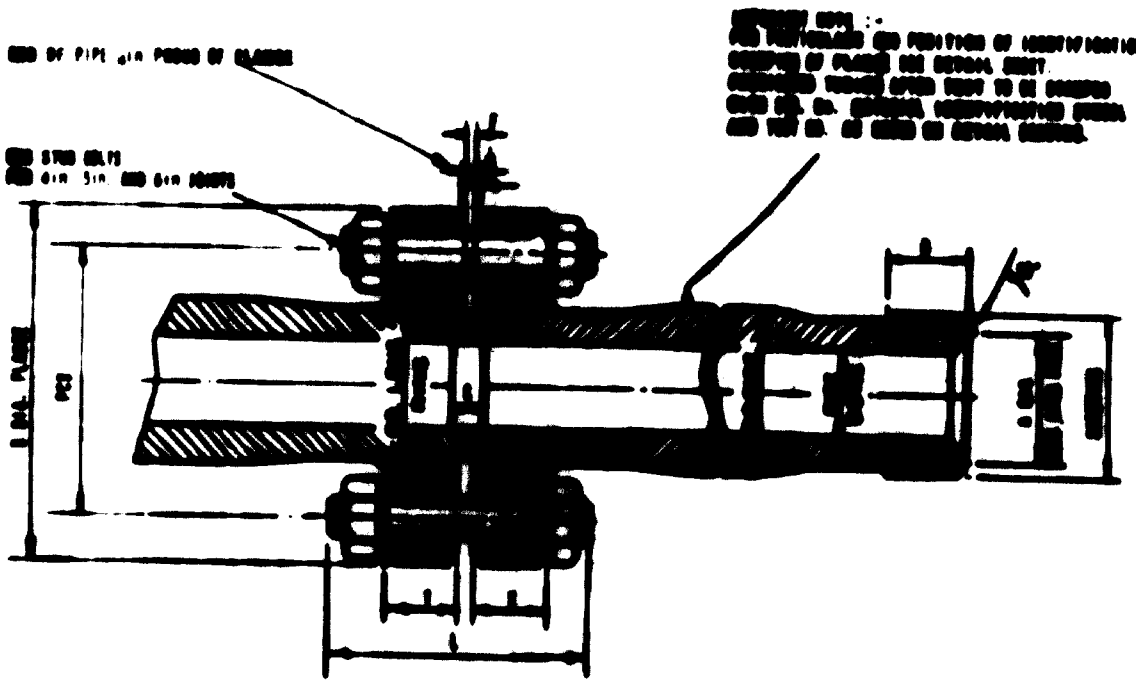
**GENERAL REFERENCES**

- TUBES DD 0700
- FLANGES DD 0200
- LONG STUDS DD 0000
- STUD BOLTS DD 0509

**SPEC. SEE STANDARD DETAILS OF COMPONENT PARTS**

FOR OTHER STANDARD APPROVALS AND MATERIALS TEST PROCEDURES, SEE TABLE.

ALL DIMENSIONS IN INCHES



SEE DETAILS OF FITS AND TOLERANCES AND USE ONLY THE FITS AND TOLERANCES FOR STANDARD 6055-01

FOR CODE OR REF. NOS. AND AGRICULTURAL DIV. REF. NUMS. SEE PAGE 2.

THIS SHEET SHALL BE KEPT UP-TO-DATE ONLY WHEN ORDERED TO A REGISTERED (C) STANDARDS BODY. LOOSE COPIES WILL NOT BE KEPT UP-TO-DATE.

SIZES	CARBON STEEL PIPE					CARBON STEEL FLANGE					BOLTS	LONG STUDS	ASST. PARTS AND SUPPLIES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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1/2"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	48"	54"	60"	72"	84"	96"	108"	120"	144"	168"	192"	216"	240"	288"	360"	432"	504"	576"	648"	720"	864"	1008"	1152"	1296"	1440"	1680"	1920"	2160"	2400"	2880"	3600"	4320"	5040"	5760"	6480"	7200"	8640"	10080"	11520"	12960"	14400"	16800"	19200"	21600"	24000"	28800"	36000"	43200"	50400"	57600"	64800"	72000"	86400"	100800"	115200"	129600"	144000"	168000"	192000"	216000"	240000"	288000"	360000"	432000"	504000"	576000"	648000"	720000"	864000"	1008000"	1152000"	1296000"	1440000"	1680000"	1920000"	2160000"	2400000"	2880000"	3600000"	4320000"	5040000"	5760000"	6480000"	7200000"	8640000"	10080000"	11520000"	12960000"	14400000"	16800000"	19200000"	21600000"	24000000"	28800000"	36000000"	43200000"	50400000"	57600000"	64800000"	72000000"	86400000"	100800000"	115200000"	129600000"	144000000"	168000000"	192000000"	216000000"	240000000"	288000000"	360000000"	432000000"	504000000"	576000000"	648000000"	720000000"	864000000"	1008000000"	1152000000"	1296000000"	1440000000"	1680000000"	1920000000"	2160000000"	2400000000"	2880000000"	3600000000"	4320000000"	5040000000"	5760000000"	6480000000"	7200000000"	8640000000"	10080000000"	11520000000"	12960000000"	14400000000"	16800000000"	19200000000"	21600000000"	24000000000"	28800000000"	36000000000"	43200000000"	50400000000"	57600000000"	64800000000"	72000000000"	86400000000"	100800000000"	115200000000"	129600000000"	144000000000"	168000000000"	192000000000"	216000000000"	240000000000"	288000000000"	360000000000"	432000000000"	504000000000"	576000000000"	648000000000"	720000000000"	864000000000"	1008000000000"	1152000000000"	1296000000000"	1440000000000"	1680000000000"	1920000000000"	2160000000000"	2400000000000"	2880000000000"	3600000000000"	4320000000000"	5040000000000"	5760000000000"	6480000000000"	7200000000000"	8640000000000"	10080000000000"	11520000000000"	12960000000000"	14400000000000"	16800000000000"	19200000000000"	21600000000000"	24000000000000"	28800000000000"	36000000000000"	43200000000000"	50400000000000"	57600000000000"	64800000000000"	72000000000000"	86400000000000"	100800000000000"	115200000000000"	129600000000000"	144000000000000"	168000000000000"	192000000000000"	216000000000000"	240000000000000"	288000000000000"	360000000000000"	432000000000000"	504000000000000"	576000000000000"	648000000000000"	720000000000000"	864000000000000"	1008000000000000"	1152000000000000"	1296000000000000"	1440000000000000"	1680000000000000"	1920000000000000"	2160000000000000"	2400000000000000"	2880000000000000"	3600000000000000"	4320000000000000"	5040000000000000"	5760000000000000"	6480000000000000"	7200000000000000"	8640000000000000"	10080000000000000"	11520000000000000"	12960000000000000"	14400000000000000"	16800000000000000"	19200000000000000"	21600000000000000"	24000000000000000"	28800000000000000"	36000000000000000"	43200000000000000"	50400000000000000"	57600000000000000"	64800000000000000"	72000000000000000"	86400000000000000"	100800000000000000"	115200000000000000"	129600000000000000"	144000000000000000"	168000000000000000"	192000000000000000"	216000000000000000"	240000000000000000"	288000000000000000"	360000000000000000"	432000000000000000"	504000000000000000"	576000000000000000"	648000000000000000"	720000000000000000"	864000000000000000"	1008000000000000000"	1152000000000000000"	1296000000000000000"	1440000000000000000"	1680000000000000000"	1920000000000000000"	2160000000000000000"	2400000000000000000"	2880000000000000000"	3600000000000000000"	4320000000000000000"	5040000000000000000"	5760000000000000000"	6480000000000000000"	7200000000000000000"	8640000000000000000"	10080000000000000000"	11520000000000000000"	12960000000000000000"	14400000000000000000"	16800000000000000000"	19200000000000000000"	21600000000000000000"	24000000000000000000"	28800000000000000000"	36000000000000000000"	43200000000000000000"	50400000000000000000"	57600000000000000000"	64800000000000000000"	72000000000000000000"	86400000000000000000"	100800000000000000000"	115200000000000000000"	129600000000000000000"	144000000000000000000"	168000000000000000000"	192000000000000000000"	216000000000000000000"	240000000000000000000"	288000000000000000000"	360000000000000000000"	432000000000000000000"	504000000000000000000"	576000000000000000000"	648000000000000000000"	720000000000000000000"	864000000000000000000"	1008000000000000000000"	1152000000000000000000"	1296000000000000000000"	1440000000000000000000"	1680000000000000000000"	1920000000000000000000"	2160000000000000000000"	2400000000000000000000"	2880000000000000000000"	3600000000000000000000"	4320000000000000000000"	5040000000000000000000"	5760000000000000000000"	6480000000000000000000"	7200000000000000000000"	8640000000000000000000"	10080000000000000000000"	11520000000000000000000"	12960000000000000000000"	14400000000000000000000"	16800000000000000000000"	19200000000000000000000"	21600000000000000000000"	24000000000000000000000"	28800000000000000000000"	36000000000000000000000"	43200000000000000000000"	504000000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NET WEIGHT	
<b>DB</b>	<b>6055</b>
PAGE 1	OF 1
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INV. ISSUE NO.	DATE

A. DIMENSIONS IN INCHES:

THE TYPICAL FOR NUMERICAL BONE SIZES 210 TO 610 INCLUSIVE, SCREW THREADS TO CONFORM TO U.S. AND BRIT. S. STANDARD CLASS 8 GRANGED TO U.S. 810.

BONE SIZE	TYPE OF USE					STUD BOLTS
	PLATE	WELD YOUNG	PLATE	WELD FOR LESS USE	WELD FOR LESS USE	
2						
3						
4						
5						
6						

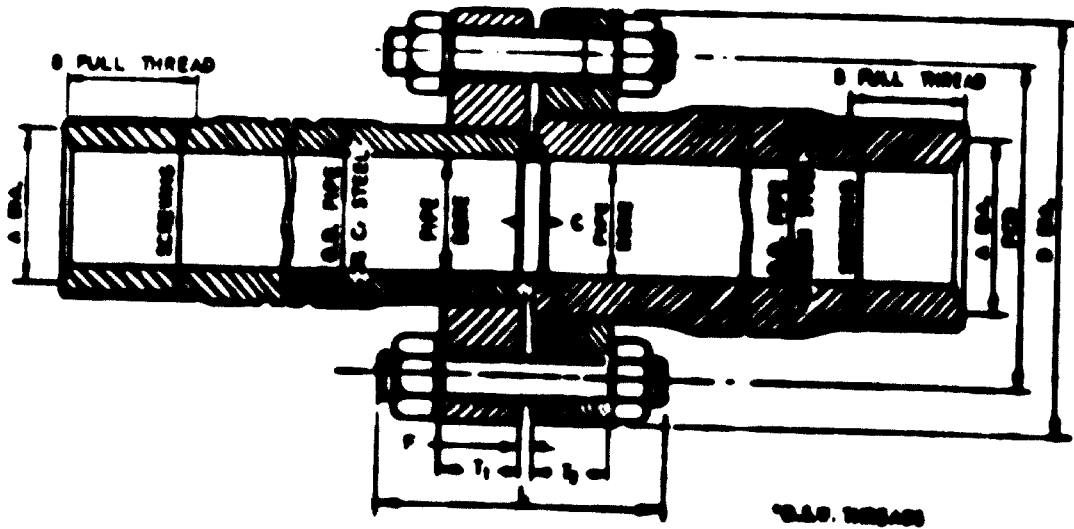
# CARBON STEEL FLANGED PIPE JOINTS

250 - 2500 PSI DESIGN PRESSURE  
CONNECTING 25 C STEEL HOT PIPELINE TO  
CARBON STEEL PIPELINE. 250°C MAX. TEMP.

DB	ID NUMBER
	6060
PAGE	1 OF 1
REV. NO.	DATE
BY	DATE

**GENERAL REFERENCES**

- |                   |                             |
|-------------------|-----------------------------|
| PIPE 25 C STEEL   | (20 2500 27                 |
| PIPE CARBON STEEL | (25 2500 25                 |
| FLANGES           | (20 2500 AND 25 2500) 2-420 |
| WASHERS           | (20 2500 24.75              |
| STUD BOLTS        | (20 2500                    |



ALL DIMENSIONS IN INCHES

NOM. SIZE	F	25 C STEEL PIPE						CARBON STEEL PIPE						FLANGE					
		O.D.	A	B	PIPE SCREWS		O.D.	A	B	PIPE SCREWS		D	T <sub>1</sub>	T <sub>2</sub>	BOLT NUTS				
					DIA.	TYPE				DIA.	TYPE				NB.	DIA.	PCD		
2	0	2 1/2	1 1/2	2 1/2	3	10	2 1/2	1 1/2	2 1/2	3	0	2 1/2	1 1/2	2 1/2	0	1 1/2	2 1/2		
3	0	3 1/2	2 1/2	3 1/2	4	10	3 1/2	2 1/2	3 1/2	4	0	3 1/2	2 1/2	3 1/2	0	2 1/2	3 1/2		
4	0	4 1/2	3 1/2	4 1/2	5	10	4 1/2	3 1/2	4 1/2	5	0	4 1/2	3 1/2	4 1/2	0	3 1/2	4 1/2		
6	0	6 1/2	5 1/2	6 1/2	7	10	6 1/2	5 1/2	6 1/2	7	0	6 1/2	5 1/2	6 1/2	0	5 1/2	6 1/2		

NOM. SIZE	STUD BOLTS		WASHERS	
	DIA.	L	DIA.	C
2	1 1/2	6 1/2	1 1/2	0
3	1 1/2	7 1/2	1 1/2	0
4	1 1/2	8 1/2	1 1/2	1
6	2	10 1/2	2	1 1/2

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# CARBON STEEL FLANGED PIPE JOINTS

400 TO 570 **psi** DESIGN PRESSURE  
300°F. TO 200°C. TEMPERATURE RANGE

ICJ REFERENCE

**DB 6075**

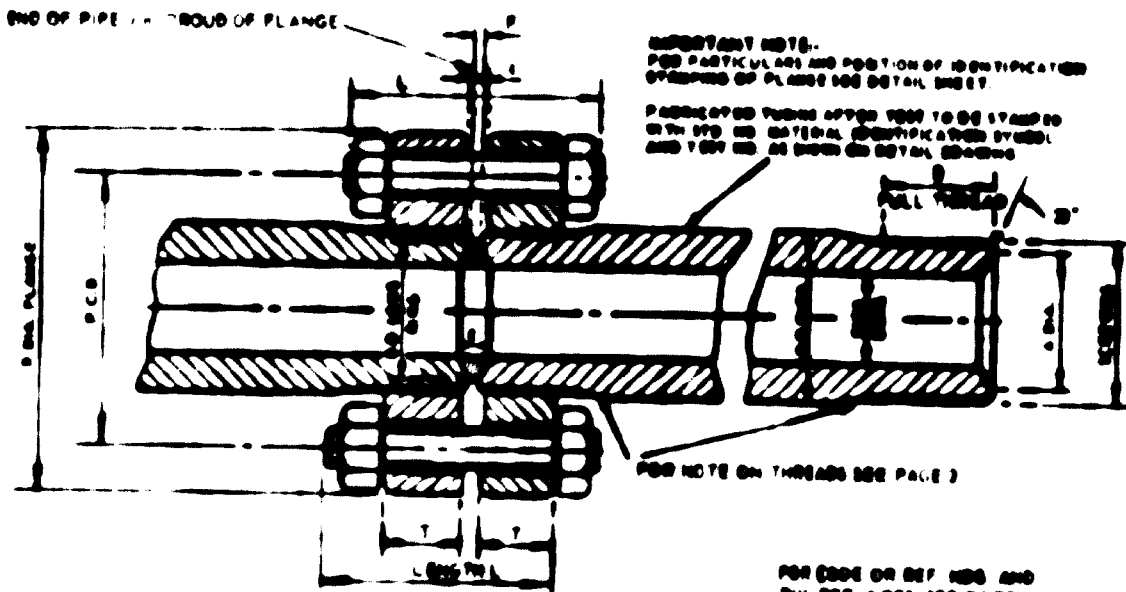
PAGE 1 OF 1  
ICJ FILE NO. 19 DATE REV. 79  
DIV. FILE NO. DATE

**GENERAL REFERENCES**

TUBES DB 5765  
FLANGES DB 5915  
LENS RING DB 6235  
STUD BOLTS DB 0589

FORMERLY B430

NOTE: FOR DESIGN, INCLUDING ATTACHABLE AND HYDRAULIC TEST PROCEDURES SEE TABLE FOR DETAILS OF TUBES DB70 NO. 10 OR TYPED L. 2 NO. 0100. FACTS SEE ADVISORY TUBING DIVISION STANDARDS IN DB 031.



FOR FLANGES UNDER THE CONTROL OF AMERICAN STEEL INSTITUTE OPERATED AT DESIGN PRESSURE AND TEMPERATURE CONDITIONS OF 400 **psi** TO 570 **psi**. THE STANDARD SPECIFIC TEST RESULTS APPLIED SHALL BE 570 **psi**, IF SPECIFICALLY IDENTIFIED IN TERMS OF 400 **psi** TO 570 **psi**. FOR THE STANDARD AND REQUIRED SPECIAL ARRANGEMENTS SEE DB 030 FOR THE SPECIFIC HYDRAULIC TESTING.

**ALL DIMENSIONS IN INCHES**

CARBON STEEL PIPE					CARBON STEEL FLANGE				STUD BOLTS		LENS RING		DESIGN PRESSURE (psi)		
NOM. SIZE	OD	A	D	PIPE THICKNESS	D	T	BOLT HOLE			OD	L	OD	C	DESIGN	TEMP. RANGE
							NO.	OD	P.C.D.						
1/2	1.315	1.315	1.315	0.083	3.0	0.1875	2	1.125	1	1.315	1.315	1.315	1.315	400	300-200
3/4	1.675	1.675	1.675	0.083	3.5	0.1875	2	1.375	1	1.675	1.675	1.675	1.675	400	300-200
1	2.000	2.000	2.000	0.083	4.0	0.1875	2	1.625	1	2.000	2.000	2.000	2.000	400	300-200
1 1/2	2.625	2.625	2.625	0.083	5.0	0.1875	2	2.125	1	2.625	2.625	2.625	2.625	400	300-200
2	3.375	3.375	3.375	0.083	6.0	0.1875	2	2.625	1	3.375	3.375	3.375	3.375	400	300-200
2 1/2	4.125	4.125	4.125	0.083	7.0	0.1875	2	3.125	1	4.125	4.125	4.125	4.125	400	300-200
3	4.875	4.875	4.875	0.083	8.0	0.1875	2	3.625	1	4.875	4.875	4.875	4.875	400	300-200
3 1/2	5.625	5.625	5.625	0.083	9.0	0.1875	2	4.125	1	5.625	5.625	5.625	5.625	400	300-200
4	6.375	6.375	6.375	0.083	10.0	0.1875	2	4.625	1	6.375	6.375	6.375	6.375	400	300-200
4 1/2	7.125	7.125	7.125	0.083	11.0	0.1875	2	5.125	1	7.125	7.125	7.125	7.125	400	300-200
5	7.875	7.875	7.875	0.083	12.0	0.1875	2	5.625	1	7.875	7.875	7.875	7.875	400	300-200
5 1/2	8.625	8.625	8.625	0.083	13.0	0.1875	2	6.125	1	8.625	8.625	8.625	8.625	400	300-200
6	9.375	9.375	9.375	0.083	14.0	0.1875	2	6.625	1	9.375	9.375	9.375	9.375	400	300-200
6 1/2	10.125	10.125	10.125	0.083	15.0	0.1875	2	7.125	1	10.125	10.125	10.125	10.125	400	300-200
7	10.875	10.875	10.875	0.083	16.0	0.1875	2	7.625	1	10.875	10.875	10.875	10.875	400	300-200
7 1/2	11.625	11.625	11.625	0.083	17.0	0.1875	2	8.125	1	11.625	11.625	11.625	11.625	400	300-200
8	12.375	12.375	12.375	0.083	18.0	0.1875	2	8.625	1	12.375	12.375	12.375	12.375	400	300-200
8 1/2	13.125	13.125	13.125	0.083	19.0	0.1875	2	9.125	1	13.125	13.125	13.125	13.125	400	300-200
9	13.875	13.875	13.875	0.083	20.0	0.1875	2	9.625	1	13.875	13.875	13.875	13.875	400	300-200
9 1/2	14.625	14.625	14.625	0.083	21.0	0.1875	2	10.125	1	14.625	14.625	14.625	14.625	400	300-200
10	15.375	15.375	15.375	0.083	22.0	0.1875	2	10.625	1	15.375	15.375	15.375	15.375	400	300-200
10 1/2	16.125	16.125	16.125	0.083	23.0	0.1875	2	11.125	1	16.125	16.125	16.125	16.125	400	300-200
11	16.875	16.875	16.875	0.083	24.0	0.1875	2	11.625	1	16.875	16.875	16.875	16.875	400	300-200
11 1/2	17.625	17.625	17.625	0.083	25.0	0.1875	2	12.125	1	17.625	17.625	17.625	17.625	400	300-200
12	18.375	18.375	18.375	0.083	26.0	0.1875	2	12.625	1	18.375	18.375	18.375	18.375	400	300-200
12 1/2	19.125	19.125	19.125	0.083	27.0	0.1875	2	13.125	1	19.125	19.125	19.125	19.125	400	300-200
13	19.875	19.875	19.875	0.083	28.0	0.1875	2	13.625	1	19.875	19.875	19.875	19.875	400	300-200
13 1/2	20.625	20.625	20.625	0.083	29.0	0.1875	2	14.125	1	20.625	20.625	20.625	20.625	400	300-200
14	21.375	21.375	21.375	0.083	30.0	0.1875	2	14.625	1	21.375	21.375	21.375	21.375	400	300-200
14 1/2	22.125	22.125	22.125	0.083	31.0	0.1875	2	15.125	1	22.125	22.125	22.125	22.125	400	300-200
15	22.875	22.875	22.875	0.083	32.0	0.1875	2	15.625	1	22.875	22.875	22.875	22.875	400	300-200
15 1/2	23.625	23.625	23.625	0.083	33.0	0.1875	2	16.125	1	23.625	23.625	23.625	23.625	400	300-200
16	24.375	24.375	24.375	0.083	34.0	0.1875	2	16.625	1	24.375	24.375	24.375	24.375	400	300-200
16 1/2	25.125	25.125	25.125	0.083	35.0	0.1875	2	17.125	1	25.125	25.125	25.125	25.125	400	300-200
17	25.875	25.875	25.875	0.083	36.0	0.1875	2	17.625	1	25.875	25.875	25.875	25.875	400	300-200
17 1/2	26.625	26.625	26.625	0.083	37.0	0.1875	2	18.125	1	26.625	26.625	26.625	26.625	400	300-200
18	27.375	27.375	27.375	0.083	38.0	0.1875	2	18.625	1	27.375	27.375	27.375	27.375	400	300-200
18 1/2	28.125	28.125	28.125	0.083	39.0	0.1875	2	19.125	1	28.125	28.125	28.125	28.125	400	300-200
19	28.875	28.875	28.875	0.083	40.0	0.1875	2	19.625	1	28.875	28.875	28.875	28.875	400	300-200
19 1/2	29.625	29.625	29.625	0.083	41.0	0.1875	2	20.125	1	29.625	29.625	29.625	29.625	400	300-200
20	30.375	30.375	30.375	0.083	42.0	0.1875	2	20.625	1	30.375	30.375	30.375	30.375	400	300-200
20 1/2	31.125	31.125	31.125	0.083	43.0	0.1875	2	21.125	1	31.125	31.125	31.125	31.125	400	300-200
21	31.875	31.875	31.875	0.083	44.0	0.1875	2	21.625	1	31.875	31.875	31.875	31.875	400	300-200
21 1/2	32.625	32.625	32.625	0.083	45.0	0.1875	2	22.125	1	32.625	32.625	32.625	32.625	400	300-200
22	33.375	33.375	33.375	0.083	46.0	0.1875	2	22.625	1	33.375	33.375	33.375	33.375	400	300-200
22 1/2	34.125	34.125	34.125	0.083	47.0	0.1875	2	23.125	1	34.125	34.125	34.125	34.125	400	300-200
23	34.875	34.875	34.875	0.083	48.0	0.1875	2	23.625	1	34.875	34.875	34.875	34.875	400	300-200
23 1/2	35.625	35.625	35.625	0.083	49.0	0.1875	2	24.125	1	35.625	35.625	35.625	35.625	400	300-200
24	36.375	36.375	36.375	0.083	50.0	0.1875	2	24.625	1	36.375	36.375	36.375	36.375	400	300-200
24 1/2	37.125	37.125	37.125	0.083	51.0	0.1875	2	25.125	1	37.125	37.125	37.125	37.125	400	300-200
25	37.875	37.875	37.875	0.083	52.0	0.1875	2	25.625	1	37.875	37.875	37.875	37.875	400	300-200
25 1/2	38.625	38.625	38.625	0.083	53.0	0.1875	2	26.125	1	38.625	38.625	38.625	38.625	400	300-200
26	39.375	39.375	39.375	0.083	54.0	0.1875	2	26.625	1	39.375	39.375	39.375	39.375	400	300-200
26 1/2	40.125	40.125	40.125	0.083	55.0	0.1875	2	27.125	1	40.125	40.125	40.125	40.125	400	300-200
27	40.875	40.875	40.875	0.083	56.0	0.1875	2	27.625	1	40.875	40.875	40.875	40.875	400	300-200
27 1/2	41.625	41.625	41.625	0.083	57.0	0.1875	2	28.125	1	41.625	41.625	41.625	41.625	400	300-200
28	42.375	42.375	42.375	0.083	58.0	0.1875	2	28.625	1	42.375	42.375	42.375	42.375	400	300-200
28 1/2	43.125	43.125	43.125	0.083	59.0	0.1875	2	29.125	1	43.125	43.125	43.125	43.125	400	300-200
29	43.875	43.875	43.875	0.083	60.0	0.1875	2	29.625	1	43.875	43.875	43.875	43.875	400	300-200
29 1/2	44.625	44.625	44.625	0.083	61.0	0.1875	2	30.125	1	44.625	44.625	44.625	44.625	400	300-200
30	45.375	45.375	45.375	0.083	62.0	0.1875	2	30.625	1	45.375	45.375	45.375	45.375	400	300-200
30 1/2	46.125	46.125	46.125	0.083	63.0										

DB 6075	

NOTE: THESE - FOR GENERAL USE CLASS (G.A. TO 2474). MAILING USES THESE S.S.P.F. TO  
 CORRESPOND TO S.S.P.F. GENERAL CLASS (G.A. TO 2474).  
 FOR GENERAL USE CLASS (G.A. TO 2474). MAILING USES THESE TO CORRESPOND TO S.S.P.F.  
 S.S.P.F. GENERAL CLASS (G.A. TO 2474).

ALL ENTRIES IN THIS

NO.	TYPE OF USE		
	PLANT	FIELD	PLANT
1	PLANT	PLANT	PLANT
2	PLANT	PLANT	PLANT
3	PLANT	PLANT	PLANT
4	PLANT	PLANT	PLANT
5	PLANT	PLANT	PLANT
6	PLANT	PLANT	PLANT
7	PLANT	PLANT	PLANT
8	PLANT	PLANT	PLANT
9	PLANT	PLANT	PLANT

NO.	TYPE OF USE			
	PLANT	FIELD	PLANT	PLANT
1	PLANT	PLANT	PLANT	PLANT
2	PLANT	PLANT	PLANT	PLANT
3	PLANT	PLANT	PLANT	PLANT
4	PLANT	PLANT	PLANT	PLANT
5	PLANT	PLANT	PLANT	PLANT
6	PLANT	PLANT	PLANT	PLANT
7	PLANT	PLANT	PLANT	PLANT
8	PLANT	PLANT	PLANT	PLANT
9	PLANT	PLANT	PLANT	PLANT

# CARBON STEEL FLANGED PIPE JOINTS

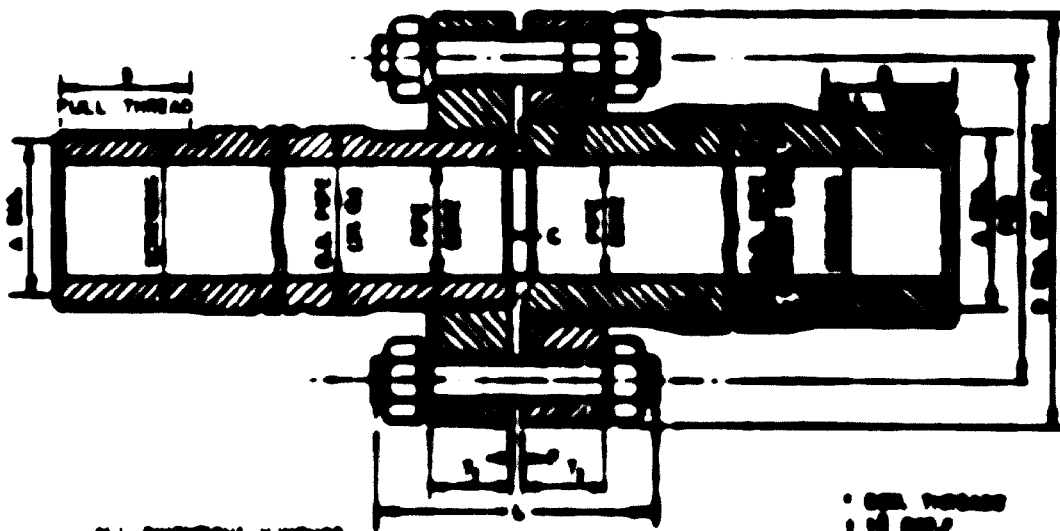
400 - 435 psi DESIGN PRESSURE  
CONNECTING 35 C STEEL HOT PIPELINE TO  
CARBON STEEL PIPELINE. 200°C MAX. TEMP.

DB

6078

**GENERAL REFERENCES**

PIPE 35 C. STEEL	100 0200 037
PIPE CARBON STEEL	100 0200 037
FLANGES	100 0200 037 0371 0 200
LONG BOLTS	100 0200 0475
STUD BOLTS	100 0200



ALL DIMENSIONS IN INCHES

GASKET THICKNESS  
1/16\"/>

NOM. SIZE	35 C. STEEL PIPE				CARBON STEEL PIPE				FLANGE						
	OD		W.T.		OD		W.T.		NOM. SIZE	OD	W.T.	NOM. SIZE	OD	W.T.	
	IN.	MM.	IN.	MM.	IN.	MM.	IN.	MM.							
1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	1/2	1.315	0.083	1/2	1.315	0.083
3/4	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	3/4	1.315	0.083	3/4	1.315	0.083
1	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	1	1.315	0.083	1	1.315	0.083
1 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	1 1/2	1.315	0.083	1 1/2	1.315	0.083
2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	2	1.315	0.083	2	1.315	0.083
2 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	2 1/2	1.315	0.083	2 1/2	1.315	0.083
3	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	3	1.315	0.083	3	1.315	0.083
3 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	3 1/2	1.315	0.083	3 1/2	1.315	0.083
4	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	4	1.315	0.083	4	1.315	0.083
4 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	4 1/2	1.315	0.083	4 1/2	1.315	0.083
5	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	5	1.315	0.083	5	1.315	0.083
5 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	5 1/2	1.315	0.083	5 1/2	1.315	0.083
6	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	6	1.315	0.083	6	1.315	0.083
6 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	6 1/2	1.315	0.083	6 1/2	1.315	0.083
7	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	7	1.315	0.083	7	1.315	0.083
7 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	7 1/2	1.315	0.083	7 1/2	1.315	0.083
8	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	8	1.315	0.083	8	1.315	0.083
8 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	8 1/2	1.315	0.083	8 1/2	1.315	0.083
9	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	9	1.315	0.083	9	1.315	0.083
9 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	9 1/2	1.315	0.083	9 1/2	1.315	0.083
10	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	10	1.315	0.083	10	1.315	0.083
10 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	10 1/2	1.315	0.083	10 1/2	1.315	0.083
11	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	11	1.315	0.083	11	1.315	0.083
11 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	11 1/2	1.315	0.083	11 1/2	1.315	0.083
12	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	12	1.315	0.083	12	1.315	0.083
12 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	12 1/2	1.315	0.083	12 1/2	1.315	0.083
13	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	13	1.315	0.083	13	1.315	0.083
13 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	13 1/2	1.315	0.083	13 1/2	1.315	0.083
14	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	14	1.315	0.083	14	1.315	0.083
14 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	14 1/2	1.315	0.083	14 1/2	1.315	0.083
15	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	15	1.315	0.083	15	1.315	0.083
15 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	15 1/2	1.315	0.083	15 1/2	1.315	0.083
16	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	16	1.315	0.083	16	1.315	0.083
16 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	16 1/2	1.315	0.083	16 1/2	1.315	0.083
17	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	17	1.315	0.083	17	1.315	0.083
17 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	17 1/2	1.315	0.083	17 1/2	1.315	0.083
18	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	18	1.315	0.083	18	1.315	0.083
18 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	18 1/2	1.315	0.083	18 1/2	1.315	0.083
19	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	19	1.315	0.083	19	1.315	0.083
19 1/2	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	19 1/2	1.315	0.083	19 1/2	1.315	0.083
20	1.315	33.0	0.083	2.1	53.3	0.083	0.083	0.083	0.083	20	1.315	0.083	20	1.315	0.083

NOM. SIZE	OD	W.T.
1/2	1.315	0.083
3/4	1.315	0.083
1	1.315	0.083
1 1/2	1.315	0.083
2	1.315	0.083
2 1/2	1.315	0.083
3	1.315	0.083
3 1/2	1.315	0.083
4	1.315	0.083
4 1/2	1.315	0.083
5	1.315	0.083
5 1/2	1.315	0.083
6	1.315	0.083
6 1/2	1.315	0.083
7	1.315	0.083
7 1/2	1.315	0.083
8	1.315	0.083
8 1/2	1.315	0.083
9	1.315	0.083
9 1/2	1.315	0.083
10	1.315	0.083
10 1/2	1.315	0.083
11	1.315	0.083
11 1/2	1.315	0.083
12	1.315	0.083
12 1/2	1.315	0.083
13	1.315	0.083
13 1/2	1.315	0.083
14	1.315	0.083
14 1/2	1.315	0.083
15	1.315	0.083
15 1/2	1.315	0.083
16	1.315	0.083
16 1/2	1.315	0.083
17	1.315	0.083
17 1/2	1.315	0.083
18	1.315	0.083
18 1/2	1.315	0.083
19	1.315	0.083
19 1/2	1.315	0.083
20	1.315	0.083



# CARBON STEEL FLANGED PIPE JOINTS

THIS DRAWING FOR DESIGN PURPOSES  
SHOWS DIMENSIONS  
FROM 1/2" TO 10" NOMINAL SIZE

DB	6080

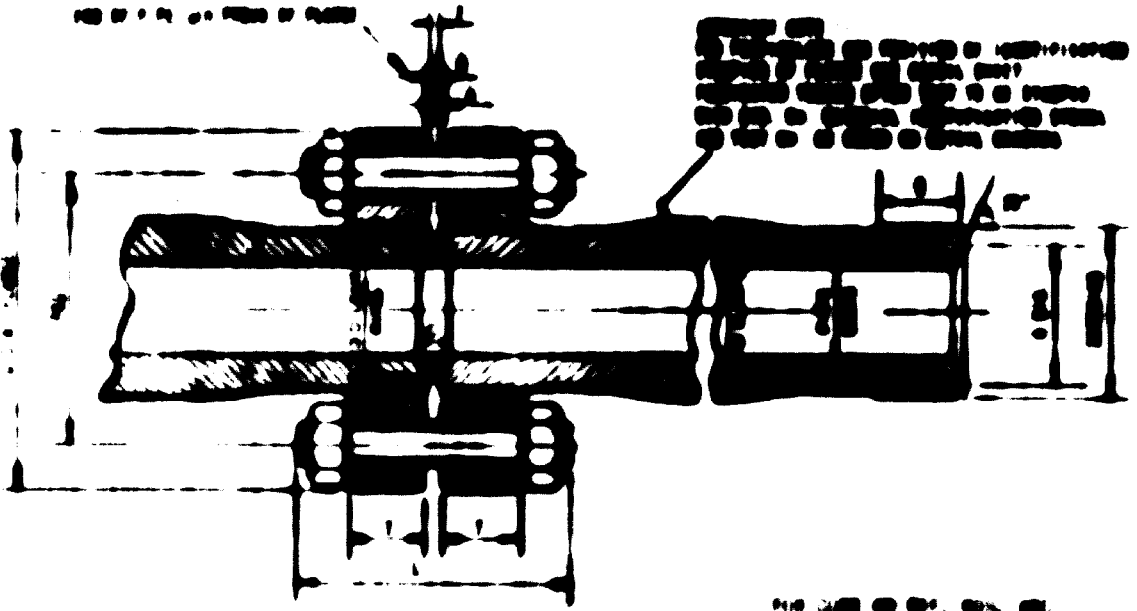
NOTE:  
1. DIMENSIONS  
FOR 1/2" TO  
1" NOMINAL  
SIZE

NO. 1700  
NO. 1701  
NO. 1702  
NO. 1703  
NO. 1704

SEE ALSO THE DRAWING SHEETS OF  
RELEVANT PARTS

SEE ALSO THE DRAWING

FOR DIMENSIONS REFER TO THE DRAWING  
NOT REPRODUCED FOR TABLE  
FOR DETAILS OF THE JOINT SEE THE DRAWING  
PARTS FOR THE JOINT SEE THE DRAWING



SEE ALSO THE DRAWING SHEETS OF  
RELEVANT PARTS

NO.	DESCRIPTION	QTY.	UNIT	REMARKS
1	PIPE	1	FT.	
2	FLANGE	1	PC.	
3	GASKET	1	PC.	
4	BOLT	4	PC.	
5	NUT	4	PC.	
6	WASHER	4	PC.	
7	SPACER	1	PC.	
8	KEY	1	PC.	
9	KEYWAY	1	PC.	
10	KEYWAY	1	PC.	
11	KEYWAY	1	PC.	
12	KEYWAY	1	PC.	
13	KEYWAY	1	PC.	
14	KEYWAY	1	PC.	
15	KEYWAY	1	PC.	
16	KEYWAY	1	PC.	
17	KEYWAY	1	PC.	
18	KEYWAY	1	PC.	
19	KEYWAY	1	PC.	
20	KEYWAY	1	PC.	
21	KEYWAY	1	PC.	
22	KEYWAY	1	PC.	
23	KEYWAY	1	PC.	
24	KEYWAY	1	PC.	
25	KEYWAY	1	PC.	
26	KEYWAY	1	PC.	
27	KEYWAY	1	PC.	
28	KEYWAY	1	PC.	
29	KEYWAY	1	PC.	
30	KEYWAY	1	PC.	
31	KEYWAY	1	PC.	
32	KEYWAY	1	PC.	
33	KEYWAY	1	PC.	
34	KEYWAY	1	PC.	
35	KEYWAY	1	PC.	
36	KEYWAY	1	PC.	
37	KEYWAY	1	PC.	
38	KEYWAY	1	PC.	
39	KEYWAY	1	PC.	
40	KEYWAY	1	PC.	
41	KEYWAY	1	PC.	
42	KEYWAY	1	PC.	
43	KEYWAY	1	PC.	
44	KEYWAY	1	PC.	
45	KEYWAY	1	PC.	
46	KEYWAY	1	PC.	
47	KEYWAY	1	PC.	
48	KEYWAY	1	PC.	
49	KEYWAY	1	PC.	
50	KEYWAY	1	PC.	





# FLANGED PIPE JOINTS - 15 Cr. STEEL

30 °C MAX WORKING TEMP

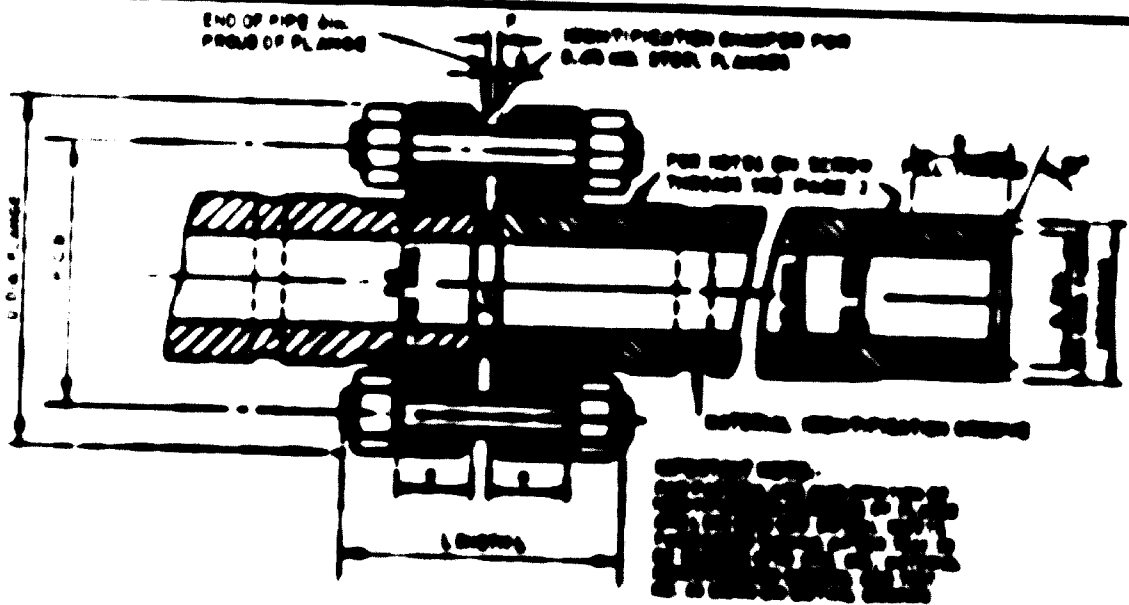
DESIGN	M.A. REFERENCE	
	DB	6115

<p>SPEC. BY STANDARD SPEC? (if standard spec)</p> <p>NOTE: SPEC</p>	<p>M.A. REF. BY: (if any)</p> <p>BY: (if any)</p> <p>BY: (if any)</p>
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**GENERAL REQUIREMENTS**

PIPE - AS C. SPEC	AS PER
FLANGES - AS PER SPEC	AS PER
WELDING - AS PER SPEC	AS PER
COATING - AS PER SPEC	AS PER

THE DESIGNER SHALL SPECIFY THE TYPE AND GRADE OF STEEL TO BE USED FOR THE PIPE AND FLANGES AND THE TYPE OF WELDING TO BE USED FOR THE JOINTS.



FOR CODE ON PIPE END AND END SPECIFIED ON PAGE 1

THE DESIGNER SHALL SPECIFY THE TYPE AND GRADE OF STEEL TO BE USED FOR THE PIPE AND FLANGES AND THE TYPE OF WELDING TO BE USED FOR THE JOINTS.

\*EXTRA THICK BOLTS TO BE USED AND LOCKED STEEL CAPS BE NECESSARY ON PIPE SPANNS SHOULD BE SPECIFIED

**M.A. REQUIREMENTS IN TABLE**

PIPE					FLANGE					END	END
NO.	MA	A	P	PIPE	NO.	MA	A	P	FLANGE	END	END
1				0.25	1				0.25		
2				0.50	2				0.50		
3				0.75	3				0.75		
4				1.00	4				1.00		
5				1.25	5				1.25		
6				1.50	6				1.50		
7				1.75	7				1.75		
8				2.00	8				2.00		
9				2.25	9				2.25		
10				2.50	10				2.50		
11				2.75	11				2.75		
12				3.00	12				3.00		



**30 CR STEEL PLATED PIPE JOINTS**  
 30 CR STEEL PLATED PIPE JOINTS  
 30 CR STEEL PLATED PIPE JOINTS

GROUP	MCA REFERENCE	
	10	000

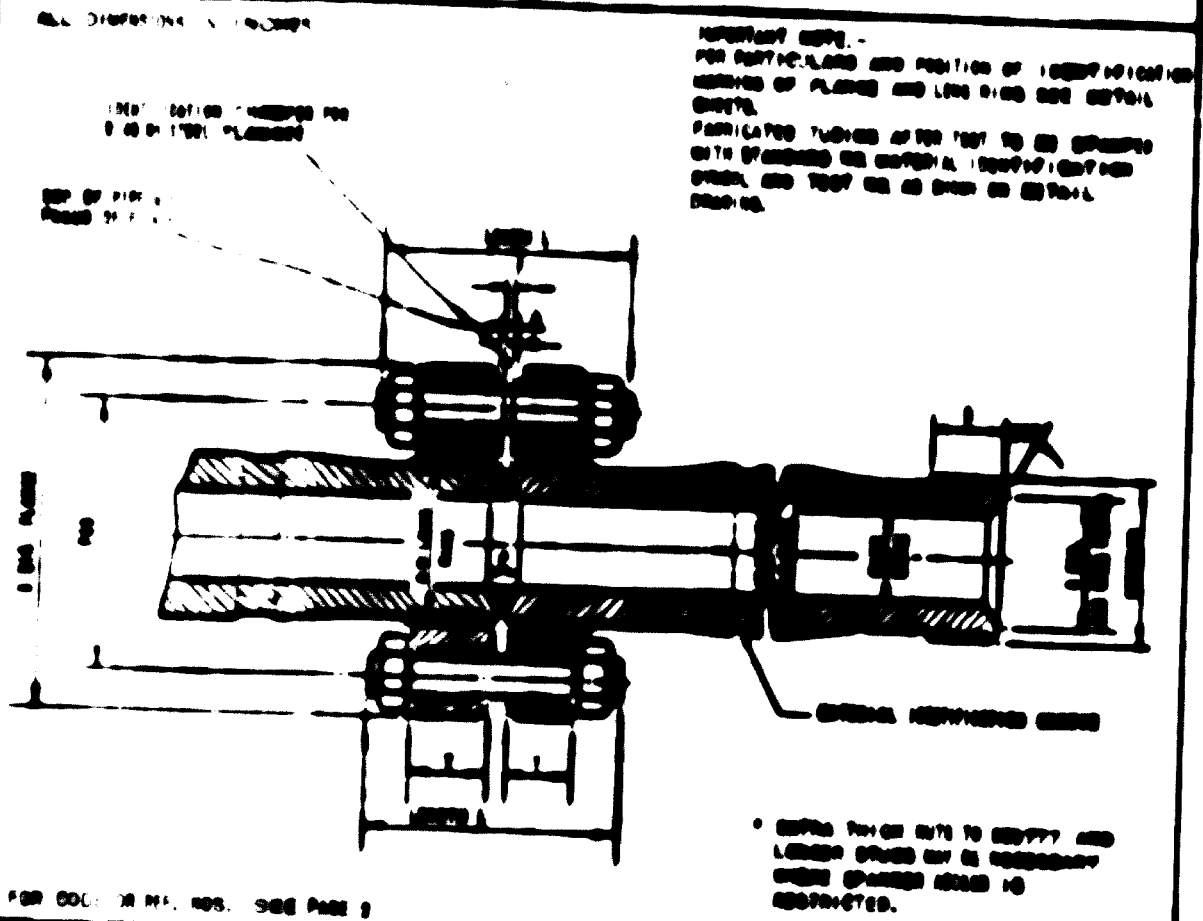
SPEC. IN PLATING GUIDE OF  
 30 CR STEEL

PAGE 1 OF 1  
 MCA 30 CR STEEL  
 30 CR STEEL  
 30 CR STEEL

GENERAL REFERENCE

GROUP 10 30 CR STEEL	10 000
GROUP 10 30 CR STEEL	10 000
GROUP 10 30 CR STEEL	10 000
GROUP 10 30 CR STEEL	10 000

NOTE: THE JOINT SHOULD BE STRENGTHENED BY STRENGTHENING THE JOINT AS SHOWN ON DRAWING



FOR COLOR IN H.S. NOS. SEE PAGE 2

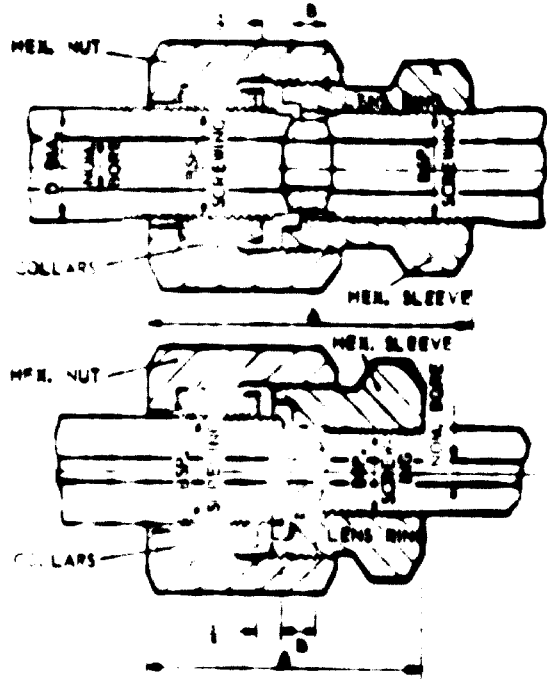
NOTE: THE JOINT SHOULD BE STRENGTHENED BY STRENGTHENING THE JOINT AS SHOWN ON DRAWING

PWS			PLATE	END	END
0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

<b>QUANTITY</b>	<b>M.A. REFERENCE</b>		<b>20 00 STEEL FLANGED PIPE JOINTS</b> 040 000000 00 0000 0000 0000 0000 0000 0000																																																																																											
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<p style="text-align: center;">                     THROUGH: FOR GENERAL SIZE 0000 000 TO 010 INCLUSIVE BORED THREADS                      U. S. P. P.                      TO CORRECT TO U. S. 0000 000000 CLASS CHANGED TO U. S. 000                      FOR GENERAL SIZE 01200 0100 AND OVER BORED THREADS TO                      JOINTS TO U. S. 00 0001.0. 000000 CLASS CHANGED TO U. S. 010.                 </p> <p style="text-align: center;"><b>M.A. 000000 00 0000</b></p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th colspan="5">M.A. 000000 00 0000</th> </tr> <tr> <th>SIZE</th> <th>000</th> <th>0000</th> <th>0000 000</th> <th>0000</th> </tr> </thead> <tbody> <tr><td>0</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>1</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>2</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>3</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>4</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>5</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>6</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>7</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>8</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>9</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>0</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>1</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>2</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>3</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>4</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> <tr><td>5</td><td>000/00</td><td>000/00</td><td>000/00</td><td>0000 00</td></tr> </tbody> </table>					M.A. 000000 00 0000					SIZE	000	0000	0000 000	0000	0	000/00	000/00	000/00	0000 00	1	000/00	000/00	000/00	0000 00	2	000/00	000/00	000/00	0000 00	3	000/00	000/00	000/00	0000 00	4	000/00	000/00	000/00	0000 00	5	000/00	000/00	000/00	0000 00	6	000/00	000/00	000/00	0000 00	7	000/00	000/00	000/00	0000 00	8	000/00	000/00	000/00	0000 00	9	000/00	000/00	000/00	0000 00	0	000/00	000/00	000/00	0000 00	1	000/00	000/00	000/00	0000 00	2	000/00	000/00	000/00	0000 00	3	000/00	000/00	000/00	0000 00	4	000/00	000/00	000/00	0000 00	5	000/00	000/00	000/00	0000 00
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<b>PIPE COUPLING SCREWED</b> CARBON STEEL, BILLINGHAM DESIGN 495 cm		DIVISION	I.C.J. REFERENCE
		<b>DB</b>	<b>6212</b>
		PAGE 1	OF 2
		I.C.J. ISSUE NO. & DATE	
		DIV. FILE NO. DATE	
		REF. DES.	
SPECL. B.S.970 G-30, G-30 OR G-4			
INFN. SHEET			
GENERAL REFERENCES		NOTE - BARELY ATTAINABLE PRESENCE OF ASSOCIATED COUPLINGS WITH ASSOCIATED PIPES - 495 cm HYDRAULIC TEST PRESSURE - 600 cm MAXIMUM ALLOWABLE TEMPERATURE - 350°C	

ALL DIMENSIONS IN INCHES



**NOTES REGARDING THE ASSEMBLY OF ALL COUPLERS**

SLEEVE TO BE SCREWED BACK ON PIPE UNTIL ITS POINT FACE IS FLUSH WITH LENS END AS SHOWN.

TWO COLLARS TO BE SCREWED HARD AGAINST EACH OTHER LEAVING A GAP AT THE END OF THE PIPE OR FITTING AS SHOWN.

1/2 IN. HP. TUBE TO 620 (60 MPN) TO BE SCREWED 1/2 IN. BSP F 1/2 IN. LONG TWO END THREADS REMOVED. TUBE END FACED FOR LENS END.

1/2 IN. HP. TUBE TO 620 (60 MPN) TO BE SCREWED 1/2 IN. BSP F 1/2 IN. LONG TWO END THREADS REMOVED. TUBE END FACED FOR LENS END.

ALL THREADS TO B.S. 3779 MEDIUM CLASS GRADE TO B.S. 970.

FOR DETAILS OF ITEMS WITH 10/32 IN. TIPPED LENS END FACES SEE AGRICULTURAL DIVISION STD B.220-201.

COUPLING COMPONENTS, NUT, COLLARS AND SLEEVE TO BE CLEARLY STAMPED WITH FULL CODE REF. AND MATERIAL SYMBOL.

B.S. 970 G-30 MATERIAL SYMBOL 916  
B.S. 970 G-30 MATERIAL SYMBOL 916  
B.S. 970 G-4 MATERIAL SYMBOL 916

FITTING SCREWED  
3/4 IN. BSP F 1/2 IN. LONG

FOR COUPLING COMPONENTS, NUT, COLLARS  
AND SLEEVE DETAILS SEE PAGE 2

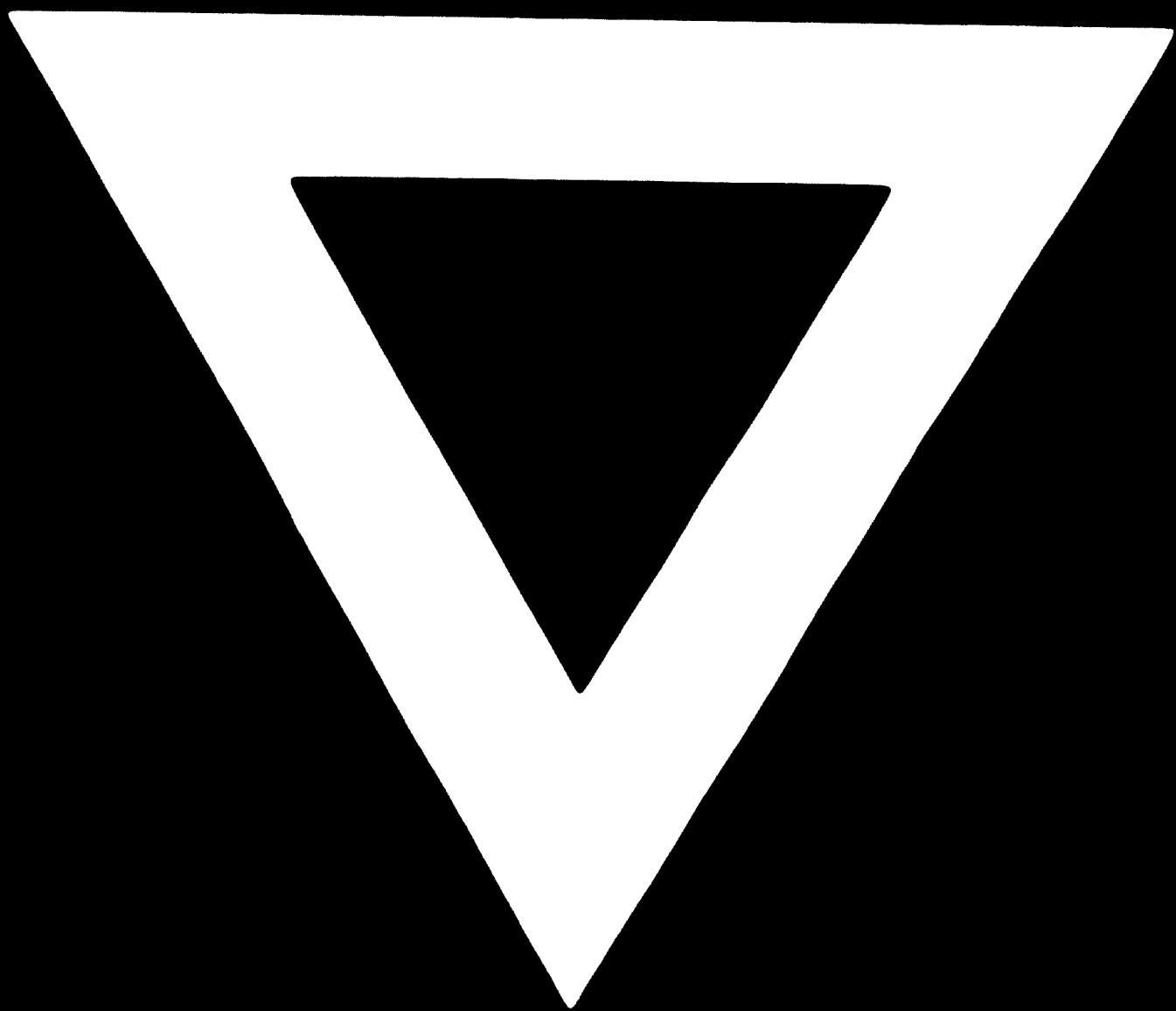
\* COUPLING ASSEMBLY SUPPLIED COMPLETE WITH NUT,  
COLLARS, SLEEVE AND LENS END.

TUBE					COUPLING		CODE OR REF. NO.		
NOM. BORE	SCREWS BSP.F	G.A.	THRS	SPECL.	A	B	*COUPLING	TUBE	LENS END
1	1/2	0	1	MFL DIVISION B.200	20	1	B212P	B20/010	B010/010
1	1/2	-	-		20	2	B212B		
1	1/2	0	2		20	2	B212B	B20/00	B010/20

TUBE					COUPLING		CODE OR REF. NO.		
NOM. BORE	SCREWS BSP.F	G.A.	THRS	SPECL.	A	B	NUT	COLLAR 3 OFF	SLEEVE
1	1/2	0	1	MFL DIVISION B.200	20	1	B212A	B212P	B20/20
1	1/2	-	-		20	2		B212B	
1	1/2	0	2		20	2		B212B	B20/20





**76 . 05 . 04**