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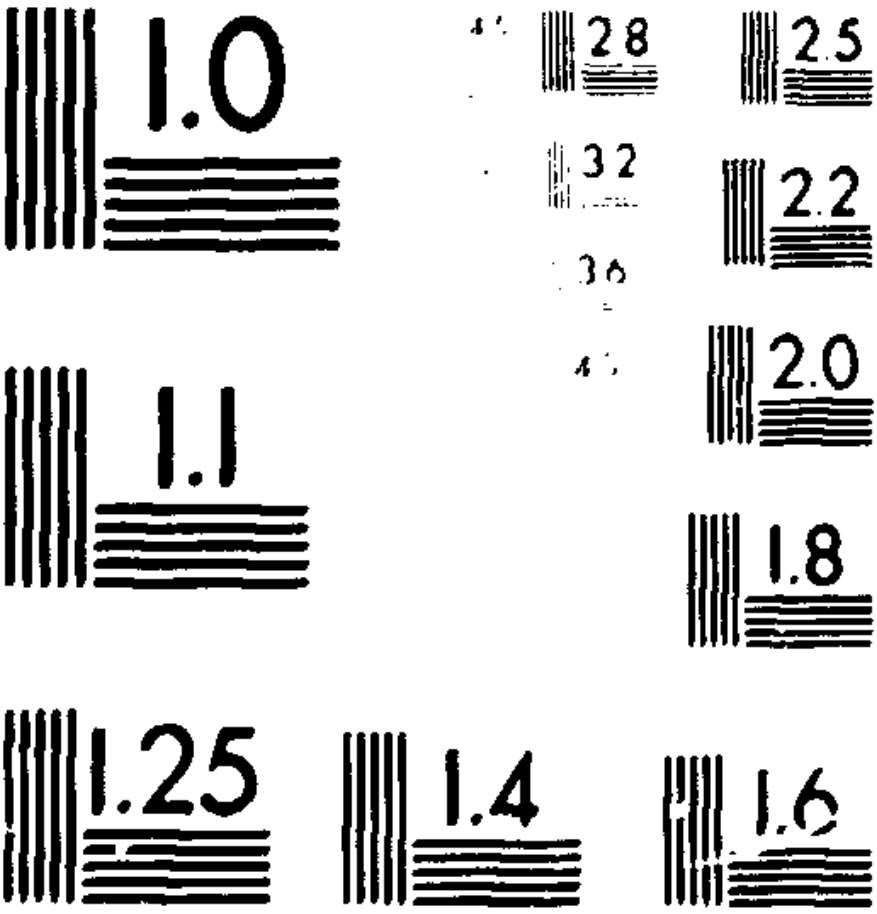

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3 March 1985

Pakistan.

TECHNICAL ASSISTANCE TO HEAVY FOUNDRY AND FORGE ENGINEERING LTD. TAXILA - PAKISTAN IN THE MANUFACTURING TECHNIQUES OF HEAVY STEEL CASTINGS.

DP/PAK/075/071/11-09

TERMINAL REPORT

Prepared for the Government of
the Islamic Republic Of Pakistan
based on the work of Tadeusz Ryterski
Expert in Foundry Technology

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
(Vienna)

This report has not been cleared with the United Nations Industrial Development Organization which does not therefore necessarily share the views presented.

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2.	Mr.M.Anwar Janjua	-	Deputy General Manager(Production)
3.	Mr.M.Siddique Javed	-	Manager(Steel Foundry)
4.	Mr.Riaz Hassan Khan	-	Manager(Cast Iron Foundry)
5.	Mr.Abdul Razic Qureshi	-	Deputy Manager (Technology)
6.	Mr.Ch.Manzoor Ahmed	-	Deputy Manager (Steel Foundry)
7.	Mr.Amjad Javed	-	Asstt.Manager (Pattern Shop)

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EXPLANATORY NOTES

The following abbreviations are being used throughout this report :

1. SEC - State Engineering Corporation of Pakistan
2. HFF - Heavy Foundry and Forge Engineering Ltd in Taxila
3. HMC - Heavy Mechanical Complex
4. QA - Quality Assurance
5. QC - Quality Control
6. NDE - Non destructive Examinations
7. MT - Magnetic particle Testing
8. UT - Ultrasonic Testing
9. PT - Dye - penetrant Testing

ABSTRACT

Under the existing operational project : TECHNICAL ASSISTANCE TO STATE ENGINEERING CORPORATION OF PAKISTAN - DP/PAK/75/07/1 there has been exercised technical advisory service to HEAVY FOUNDRY AND FORGE ENGINEERING LIMITED in Taxila in the field of manufacturing techniques of heavy steel castings.

The whole technical assistance to HFF under the above mentioned project has been conducted within three split missions a total capacity of 8 man-months.

This report is a continuance of reports, wrote by the author on completion of his previous two split missions.

The main objective of the technical assistance contributed by the author to HFF is the upgrading of heavy steel castings technology, which should result in quality improvement with the aim of meeting material quality requirements from internationally recognized standards.

The reported split mission(third and last under the project)had been lasting from 18 November 1984 till 10 March 1985(in Pakistan from 22 November 1984 till 5 March 1985).

Implementing stepwise the advices and recommendations of the author, HFF will soon be able to meet the whole demand for heavy quality castings in different steel grades from domestic market what should result in savings in foreign exchange, better utilization of existing manufacturing facilities, further improvement of casting quality and decrease of both production costs and rejection rates.

INTRODUCTION

HFF is the largest producer of quality castings and forgings in the country and has been operating metal processing since 1978.

The manufacturing programme comprised till now the following main products :

- Steel castings with an estimated production capacity of 6000t yearly
- Cast iron products with an estimated production capacity of 5000t yearly
- Wide variety of forgings with a total estimated production capacity of 15000t yearly.

Due to the market situation in Pakistan the design production estimations have not been reached so far. For these reasons HFF in addition to its present activities has recently decided to diversify the manufacturing programme by including into it complete equipment for mini-cement plants, white cement mills, small hydro power stations, automatic brick making plants and various other heavy machinery and equipment for the growing steel and iron industry in Pakistan. The diversification of the manufacturing programme should result in better utilization of the existing production capacity.

The unprecedented quick and extensive growth of the production at HFF facilities has caused many difficulties in the field of casting quality particularly in regard to heavy steel castings.

Realising the occuring problems caused by disputed and rejected castings due to their improper quality, the authorities in Pakistan have requested to provide HFF technical advisory assistance contributed by UNIDO.

The services of the author of this report have been included into the existing operational project being implemented in Pakistan under the title " TECHNICAL ASSISTANCE TO STATE ENGINEERING CORPORATION - project Number DP/PAK/75/071.

Upon request of the Government of Pakistan UNIDO and UNDP decided to provide HFF with technical assistance in a total capacity of 8 man-months split into three missions with following effects :

1. First split mission from 9 October 1983 till 17 December 1983(in Pakistan from 13 October 1983 till 14 December 1983).

2. Second split mission from 8 April 1984 till 7 June 1984(in Pakistn from 11 April 1984 till 5 June 1984).

3. Third split mission from 18 November 1984 till 10 March 1985(in Pakistan from 22 November 1984 till 5 March 1985).

The main objectives of the technical advisory assistance to HFF have been defined during a briefing session with the SIDFA Mr.M.K.Hussein on 16 October 1983 as follows :

- development of steel castings technology at HFF
- setting company standards for steel castings

The activities of the author of this report have led to a considerable improvement of steel castings quality what concerns most of the castings manufactured according to technological designs prepared by the author or by HFF technological staff with the author's help. The mutual efforts have resulted in cost savings on casting repairs by welding and in decreasing of the rejection rate, what has also been acknowledged by HMC, the most important and the biggest customer of HFF steel foundry.

The counterpart staff has been properly trained in acquaintance of advanced steel casting technology based on the principles of directional solidification of the castings.

The castings, for which technological designs have been prepared during the third split mission are specified as per list being the annexure A of this report whereas castings manufactured according to designs worked out in previous missions are listed in annexure B of the report.

Company acceptance standards, manual for technological design, heat treatment curves and other documentation have been prepared during previous missions and are being implemented stepwise alongwith the growing experience of the HFF technical staff.

The main and original objectives of the author's services to HFF have been attained.

I. RECOMMENDATIONS

1. The elaboration of the technological design of quality steel castings independent on their size and weight, should be based on thorough consideration of the principles of directional solidification in all aspects relating to casting feeding.

2. For further improvement of casting quality all principles of gating system design, specified by the author in his manual, handed over to HFF staff, should be followed as soon as proper refractory products will be available. This relates especially to such factors as rise of liquid steel in the mould cavity as well as the inflow velocity of the steel into it.

3. Further upgrading of steel casting quality may be achieved through an improvement of casting surface quality. This should be obtained by the introduction of chromite sand for the preparation of the facing sand in moulds for medium and large steel castings.

4. It is also recommended to consider the possibility of modernization of the binding system of both moulding and core sand by the application of alkyd-type of resin binder as the most suggested one.

5. As many of defects on heavy and complicated castings were caused in the past by improper feeding it is highly recommended to improve the efficiency of feeding by the introduction of very effective insulation material for casting feeders. This will also result in a much better casting yield as well as in an extension of the production capacity in regard to the height of individual castings.

6. HFF should strongly continue to replace high carbon mild steel grades by steel grades with low carbon and higher manganese content to improve the weldability of the casting material.

7. The heat treatment procedure of all castings made in mild and low alloy steel grade should be changed with immediate effect towards a full implementation of the normalizing with subsequent tempering according to diagrams elaborated by the author of this report for HFF.

8. All castings for which the author prepared technological designs with HFF staff participation,must be strictly manufactured in accordance with the stipulated outlines on calculation sheets and blueprints.

9. The draft of the technical specification for steel castings,elaborated by the author during his first split mission should be incorporated into the official documents of the QA and as such fully utilized for the material requirement negotiations with HFF customers,mainly HMC.

10. As soon as possible,MT examination of steel castings should be introduced and fully implemented. For that purpose efficient equipment is to be purchased.

11. HFF should continue the efforts towards the upgrading of the technology of castings,manufactured in copper alloys mainly in regard to heavy castings,where the rejection rate is very high. A progress here may be

achieved through the improvement of melting practice and modernization of employed gating systems as it was initiated by the author of this report. A possible extension of the centrifugal casting method should be seriously considered.

II MAIN DUTIES OF THE JOB DESCRIPTION

1. Assessment of the whole manufacturing process of heavy steel castings with particular emphasis on the quality of raw materials used and the correctness of pattern and moulding design.

2. Assessment of the equipment and procedures applied in the quality control process of steel castings and its suitability for technical requirements set by the manufacturers and customers concerned.

3. Examination of the present conditions and further prerequisites envisaged for eventual repairing of castings upon the evaluation of the nature of defects both of the surface and the internal types as result of possible technological failures.

4. Introduction whenever applicable of effective industrial methods for detecting of casting cracks and other common defects.

5. Classification of casting defects recognized technically permissible for repair of welding.

6. Preparation of detailed technological instructions for the repair of heavy cast parts.

III THE SUBSTANCE OF TECHNICAL ACTIVITIES

The main objective of the reported implementation of the project has been the upgrading of heavy steel castings manufactured by HFF because the company has faced serious quality problems in way of high rejection rates and high casting repair costs what has resulted in financial losses.

This was mainly caused by the lack of experience which for natural reasons could not guarantee the required quality of heavy and complicated steel castings with high material quality requirements.

Since additionally internationally recognized quality standards have not been acquainted by both HFF and its customers the casting quality and feasibility of casting defects repairs have aroused disputes regarding the acceptability of HFF steel cast products by the customers, mainly HMC.

The author of this report has set acceptance standards for steel castings based on well known international standards and specifications.

Furthermore the author has analysed the steel casting quality to find the main causes for improper casting quality. As a result it has been found out that the questioned casting quality is mainly affected by improper feeding and pouring as far as internal casting defects are concerned. Since HMC has introduced UT for internal casting defect detection, what has been required by the designers of the products manufactured in a cooperation between HMC and HFF and this according to common international practice,

it has been essential to update the casting technology in order to meet the set requirements.

To achieve this as a mutual effort of the report author and the HFF counterpart following activities have been exercised during all three split missions :-

- Preparation of technological manual containing comprehensive instructions for the design of steel casting technology.
- Training of HFF counterpart staff in acquainting the above mentioned manual for practical use.
- Introduction of principles of the directional solidification of steel castings in casting technology design with special emphasis to proper casting feeding and pouring.
- Introduction of standardised feeding riser shapes and sizes.
- Introduction of completely new gating systems built up in refractory sleeves and based on technically justified parameters as controlled inflow speed of steel into the mould cavity as well as controlled rise of metal level in the mould cavity during the pour.
- Introduction of out chills as means for the arrangement of conditions for directional solidification of steel castings. Elimination of internal chills as defect causing elements in castings.
- Feasibility studies of castings inquired and ordered by HFF customers.

- Preparation of technological designs for new castings ordered with HFF.

- Guidance and advisory assistance in preparation of technological designs for new castings by the HFF staff.

- Revision of previous technological designs for castings showing unsatisfactory quality.

- Assessment of the quality of castings in all phases of their manufacture i.e. as cast, after fettling, after heat treatment, prior to and after their repair by welding, during non destructive testing and during machining.

- Advisory assistance in the implementation of advanced manufacturing techniques in the patternmaking shop, moulding shop, fettling shop and melting shop.

- Consultation on welding procedures in regard of casting repairs.

- Introduction of new heat treatment cycles.

- Introduction of steel grades with high manganese content as replacement of steel grades with higher carbon content in order to improve the technological properties of casting material, mainly weldability.

- Elaboration of amendments and explanatory notes to the previously prepared instructions covered by the already mentioned manual.

- Meetings and discussion with design officers of HFF and HMC related to alterations in the casting design in order to improve their casting feasibility.

- Advisory in the introduction of new materials for the gating system and in the design of its refractory elements.

- Participation in discussion on technological matters which has surfaced in day-to-day affairs.

- Experiments in the application of insulation bricks of feeding risers.

- Consultation on non-ferrous castings technology with special regard to melting practice and gating systems.

All these activities resulted in the immediate implementation of the findings and recommendations of the author. To a very large extent the utilization has led to significant improvement of casting quality observed and recognised also by HMC.

Some of the author's recommendations and findings could not be immediately utilized. This relates mainly to new moulding materials as chromite sand and resin binders because they are not available in Pakistan and must be imported.

IV CONCLUSIONS

Heavy steel castings are being manufactured within long production cycles lasting in many cases to several months.

For these reasons a full assessment of the results of the author's services to HFF as well as complete utilization of his findings could not be achieved within his three, rather short split missions.

It is therefore highly advisable to extend technical assistance of UNIDO to HFF within the field of heavy steel casting technology according to Project concept drafted by the author for the consideration of the Government of Pakistan and UNIDO/UNDP in February 1985 and submitted to the institutions involved.

ANNEXURE " A "

LIST OF CASTING TECHNOLOGICAL DESIGNS PREPARED BY THE AUTHOR IN COOPERATION WITH HFF STAFF DURING THE THIRD MISSION

1.	Side Frame for Iron car	Drg No. E01-02-2
2.	Pivot beam for Iron car	Drg No. E01-02-3
3.	Side Frame cap for iron car	Drg No. E01-02-8
4.	Stopper for iron car	Drg No. E01-02-4
5.	Axle housing cover for iron car	Drg No. E01-02-1-7
6.	Axle housing for iron car	Drg No. E01-02-1-6
7.	Flange for axle for iron car	Drg No. E01-02-1-3
8.	Rest block for iron car	Drg No. E01-01-2
9.	Wheel for iron car	Drg No. E00-07-14-2
10.	Discharge pipe	Drg. No.6-80-0401
11.	Discharge pipe	Drg No. C50-081
12.	Trunion	Drg No. C50-073
13.	Kiln tyre	Drg No. 759
14.	Kiln tyre	customer's Inquiry
15.	Idler sprocket	Drg No. D561-6-2
16.	Bearing seat	Drg No. 01-B-3-2
17.	Steering arm	Drg No. ER2.2.00-10
18.	Roll hub	Drg No. A35-018
19.	Sprocket	Drg No. D424-3-1
20.	Sleeve for swinging coupling	Drg No. 560-071
21.	Kiln support roller	Drg No. C10-037
22.	Liner	Drg No. N6222-03-0309
23.	Gear ring	Drg.No. N5735-0201

ANNEXURE " B "

LIST OF CASTINGS MANUFACTURED ALREADY ACCORDING TO THE NEW TECHNOLOGY

1.	SUGAR MILL CHEEK	DRG NO. 0-D651-1
2.	DISCHARGE HEAD	DRG.NO. 729-72-4-2011
3.	FEED HEAD	DRG NO. 729-83-4-2001
4.	KILN ROLLER	DRG NO. 728-83-0400
5.	KILN ROLLER	DRG NO. 728-74-3-0502
6.	DRIVEN SPROCKET	DRG NO. 03-1-3-2-D801-3-2B
7.	KILN ROLLER	DRG NO. MCL20-3-708
8.	STEERING ARM	DRG NO. ER2.2.00-10
9.	TRUNION	DRG NO. C50-073
10.	SLEEVE FOR SWINGING COUPLING	DRG NO. S60-071
11.	DISCHARGE PIPE	DRG NO. N6480-0401
12.	LINER	DRG NO. N6222-03-0300
13.	THRUST ROLLER	DRG NO. 728-83-3-0502
14.	SMALL BELL	DRG NO. 026-04-021-8A-001