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Rotor Machining Investigation

(Final Year Project)

GEC ALSTHOM

ELECTROMECHANICAL

Investigation of the Machinability Problems Encountered in the Manufacture of Rotors at GEC ALSTHOM Large Generators Ltd.

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SYNOPSIS

The following report details an investigation conducted to establish why some generator rotor shaft forgings which are machined at GEC ALSTHOM prove difficult to machine while others are not, and what can be done to overcome the problem. The forgings are made from a nickel-chromium-molybdenum-vanadium steel, and the precise chemical composition of the generator rotor shaft for each contract is different. The main thrust of the analysis in this report is directed at the chemical composition of the rotor and its mechanical properties, and the effect that this will have on machinability. Complementary to the primary analysis, consideration is made of the steel making, forging and subsequent heat treatment of the rotor shaft.

CONTENTS

PREFACE

The following report describes an investigation that I undertook into difficulties that were encountered in the machining of large rotor forgings at my sponsoring employer's factory, GEC ALSTHOM Turbine Generators, Large Generator Division, Stafford Site, Lichfield Road, Stafford, ST17 4LN.

I joined the company in October 1990 on a placement for my first industrial training period. Upon successful completion of a stores re-organisation project, GEC ALSTHOM offered me sponsorship for the remaining duration of my degree studies; this has entailed returning to GEC ALSTHOM to work during summer vacations and the second industrial training period.

The investigation described here was initiated through consultation with the Manager of the Quality Department at GEC ALSTHOM, Dr. Colin Riley, as he has responsibility for specifying the chemical composition and mechanical properties of the rotors.

1.0 INTRODUCTION

My sponsoring employer, GEC ALSTHOM Large Generators manufactures rotors which are used in generators in power stations. The main component of the rotor is the rotor shaft. Rotor shafts begin life as large steel forgings, purchased from many different companies around the world, and are delivered to the factory in a basic pre-machined condition.

The main purpose of the rotor shaft is to carry the copper windings and inter-turn insulation which are positioned in axial slots in the circumference of the rotor shaft. These slots are milled axially for the full length of the rotor shaft body on large, purpose built machine tools, which use large 'wheel' type cutting tools mounted on a vertical spindle.

The machining of the axial slots of the rotor shaft is one of the key processes in the manufacture of the rotor: a great deal of metal is removed during this stage of manufacture, as much as 4000kg on the largest rotor shafts that are made, so the time taken on this process has to be kept as small as possible and hence relatively high speeds and feed rates are employed.

Occasionally, and seemingly irregularly, serious difficulties are encountered during the above mentioned slotting process: the chip produced by the cutting tool insert does not form properly causing excessive heat to build up in both the work-piece and the cutting tool. The consequence of this is 'blueing' of the rotor teeth (effectively annealing the teeth and subsequently adversely affecting the mechanical properties of the teeth), and rapid cutting tool insert wear. It becomes impossible to maintain the production targets and hence production needs to be re-scheduled. It became apparent that a comprehensive and detailed investigation was required to establish and eliminate the problems. That investigation is detailed within this report.

2.0 THE COMPANY

GEC ALSTHOM Turbine Generators, Large Generator Division was formed after the merger in 1989 of GEC Power Systems and ALSTHOM of France. The company is divided between two principal sites: Belfort in eastern France, and Stafford.

Subsequent to the merger, the manufacturing operations of the two sites have been radically changed; the Belfort site now manufactures the generator stator, while Stafford concentrates principally on the manufacture of the generator rotor.

The international demand for large 500MW to 1000MW base load generators has diminished significantly resulting in current marketing emphasis on the more compact combined cycle machines. Indeed, GEC ALSTHOM now specialises in production of 50MW to 700MW generators. These generators are installed as part of the turbine generator for power stations, both nuclear and fossil fired, in locations world-wide.

In the crudest of terms, the role of the large generator is as follows:-

A shaft rotating at 3000 rpm (for a 50Hz supply), driven by a steam turbine is directly coupled to the rotor of the large generator. The rotor acts as a large rotating electromagnet (fed by a small generator referred to as an exciter) inducing a current in the stator windings. The output from the stator is then fed via transformers to the national grid for subsequent distribution.

2.1 THE PRODUCT

A typical 135MW generator rotor has a mass of 40 tonnes; a 660MW generator can weigh anything up to 75 tonnes. Under normal operating conditions it will rotate at 3000 revolutions per minute and at speeds of up to 3600 revolutions per minute when undergoing 'overspeed testing' prior to despatch to the customer. The temperature at which the rotor operates is approximately 80°C for a hydrogen cooled generator, and the running time of the rotor is intermittent.

The typical mechanical properties that are required of the rotor shaft are high yield strength, high fracture toughness, high fatigue resistance, high creep resistance, and good magnetic permeability. All of these properties are required to be uniform across a shaft whose diameter can be anything up to 1.5m.

The chemical composition of the rotor shaft forging has evolved over the years to the present composition of 3½% Ni Cr Mo V. This specification of alloy steel is roughly based on the BS.970 (1972) steel **830M31** or the older classification BS.970 (1955) **EN27**.

Below is a generalisation of the effect of the different alloying elements on the steel. A fuller and more precise analysis of the steel and its properties is given in the discussion section of this report.

The major influence on choosing the composition is the ability to obtain the uniform properties across the entire section, this is chiefly achieved by the presence of 3½% nickel which has the effect of delaying the onset of transformation of the steel when cooling. This delay gives time for the subsequent heat treatment of the rotor to work uniformly throughout the section. The addition of approximately 1.5% chromium works in tandem with the nickel to increase the depth hardenability of the steel. Straight

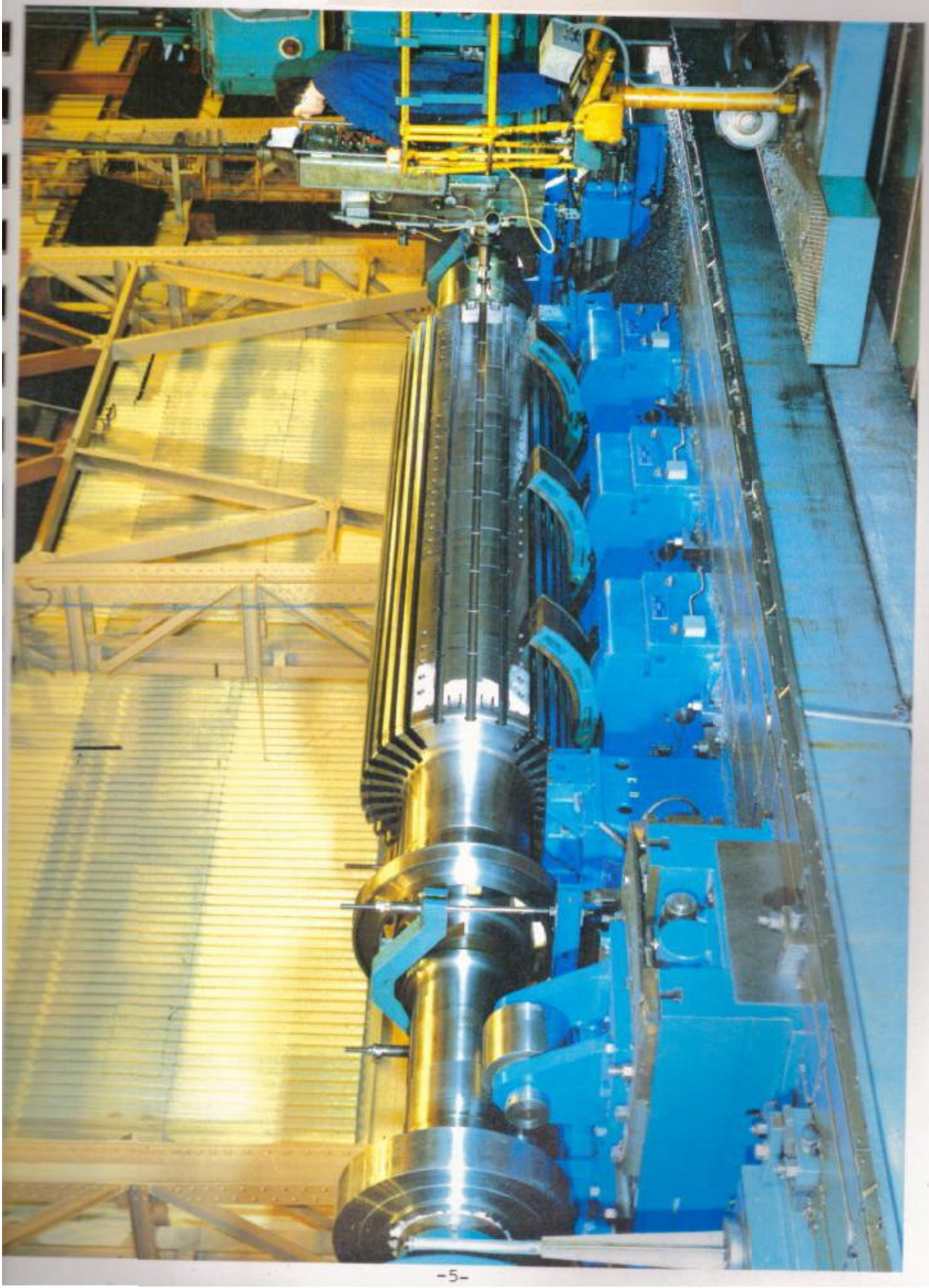
nickel-chromium steels, however, tend to suffer from temper embrittlement. The addition of approximately 0.3% to 0.5% molybdenum markedly reduces the effect, and actually promotes to some degree secondary hardening. The addition of approximately 0.1% vanadium works as a powerful de-oxidiser and therefore helps to make a 'cleaner' steel.

Other elements present in the rotor shaft forging include silicon, manganese, sulphur and phosphorus. These are generally regarded as undesirable by-products of the steel-making process, but do influence the mechanical properties and 'manufacturability' of the steel.

As well as meeting the above requirements, the chosen composition of steel needs to be economically viable.

Figure 1 overleaf shows a rotor shaft forging that is undergoing finish machining on its axial slots.

Figure 1 Rotor Shaft



3.0 PRIMARY MANUFACTURING PROCESSES

This section describes the work that is performed on the rotor by the supplier, prior to despatch to GEC ALSTHOM. It briefly details the steelmaking process, casting to ingot, forging and subsequent heat treatment.

Obviously each supplier, and GEC ALSTHOM uses many:- Forgemasters, Krupp, Mitsui, Rochling, Thyssen, Bethlehem Steel and Terni to name a few, will use their own techniques for the manufacture of the rotor shaft. In this section I have utilised information from Forgemasters Engineering in Sheffield.

3.1 STEELMAKING

The steelmaking process used by each different supplier varies somewhat, although all basically use derivations of the electric arc furnace. GEC ALSTHOM specifies that the steelmaking be degassed under vacuum.

A typical specification of chemical composition for a GEC ALSTHOM generator rotor is given in Table 1 below:-

Table 1. Chemical Composition of the Rotor Shaft

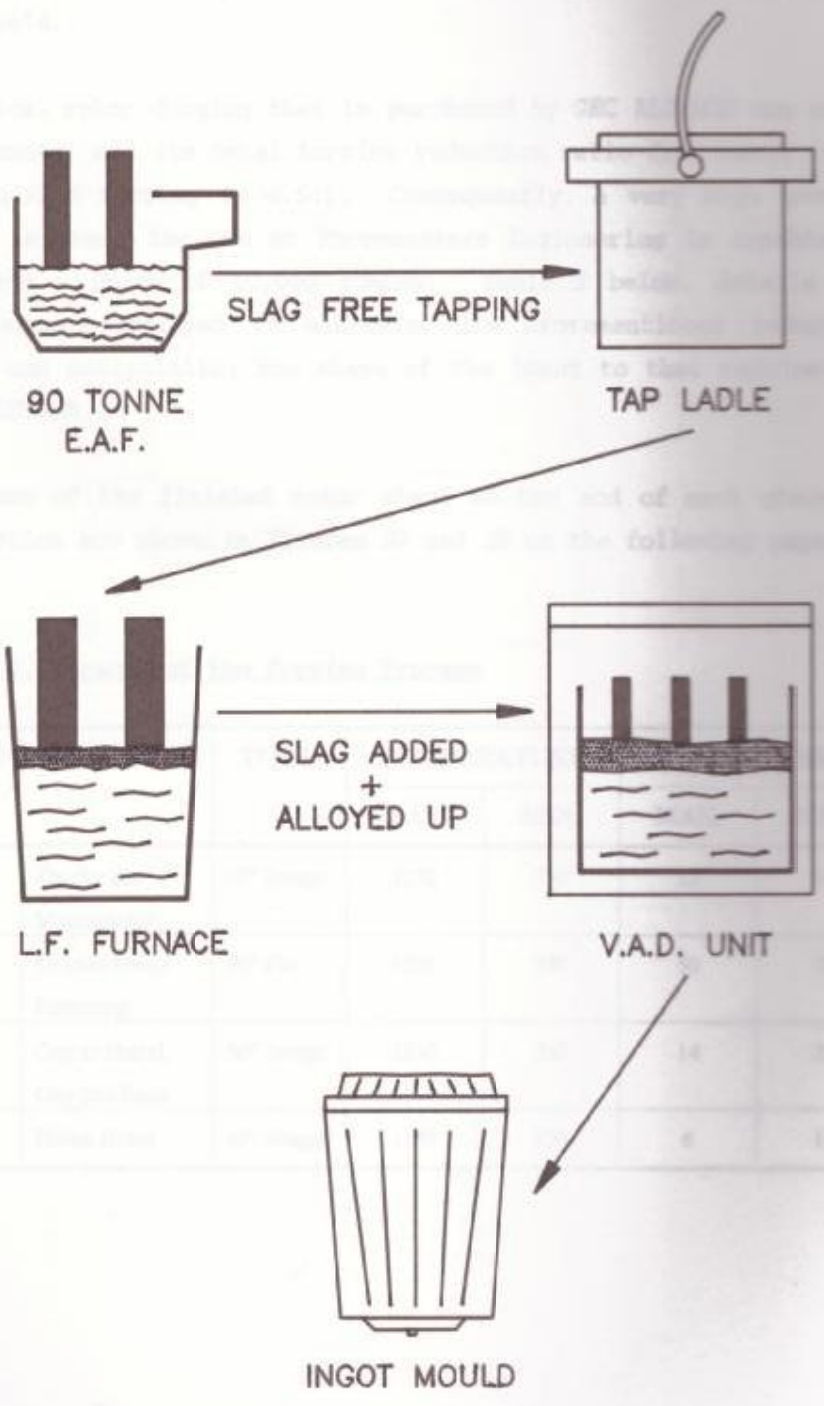
ELEMENT	% CONTENT
Carbon (C)	0.2 to 0.28 (*)
Nickel (Ni)	3.25 to 3.75
Chromium (Cr)	1.2 to 2.0
Molybdenum (Mo)	0.3 to 0.6
Vanadium (V)	0.05 to 0.15
Manganese (Mg)	0.2 to 0.4
Silicon (Si)	0.08 to 0.20
Sulphur (S)	0.005 to 0.015
Phosphorous (P)	0.015 max.
Copper (Cu)	0.15 max.
Tin (Sn)	0.015 max.
Antimony (Sb)	0.006 max.
Arsenic (As)	0.025 max.
Aluminium (Al)	0.010 max.
P + Sn	0.020 max.

(*) Maximum carbon content for cast. In the forging the carbon content shall be 0.33% max.

The primary steelmaking is carried out in an electric furnace with specialised secondary vacuum arc degassing (VAD) units for ladle refining and precise control of composition. This enables the steel to be produced to a very wide range of specifications and with a minimum of undesirable impurities. The de-oxidising agent that is used in refining the steel under vacuum conditions will be considered fully in the discussion section of this report.

Figure 2 overleaf gives a diagramatic representation of the major processes involved in the steel production.

Figure 2. Steelmaking Process



3.2 FORGING

This section describes the basic forging process that is applied to the ingot, taking the manufacturing plan of one particular supplier as an example, namely Forgemasters Engineering Ltd., Sheffield.

A typical rotor forging that is purchased by GEC ALSTHOM can weigh 180 tonnes, and its total forging reduction ratio from basic ingot to finished forging is 4.5:1. Consequently, a very high powered press is used, the one at Forgemasters Engineering is capable of exerting a force of 10,000 tonnes. Table 2 below, details the four stages employed in achieving the aforementioned reduction ratio and manipulating the shape of the ingot to that required by GEC ALSTHOM.

Diagrams of the finished rotor shape at the end of each stage of production are shown in Figures 3A and 3B on the following pages.

Table 2. Stages of the Forging Process

STAGE	OPERATION	TOOL	TEMPERATURE		SOAK TIME	
			MAX.	MIN.	MAX.	MIN.
ONE	Tag for the Manipulator	60" Swage	1270	750	22	35
TWO	Double Broad Flattening	50" Flat	1250	750	50	70
THREE	Cog to Barrel, Oxy Set Ends	50" Swage	1230	750	14	25
FOUR	Finish Rotor	40" Swage	1180	750	6	10

Figure 3A. Forging Process

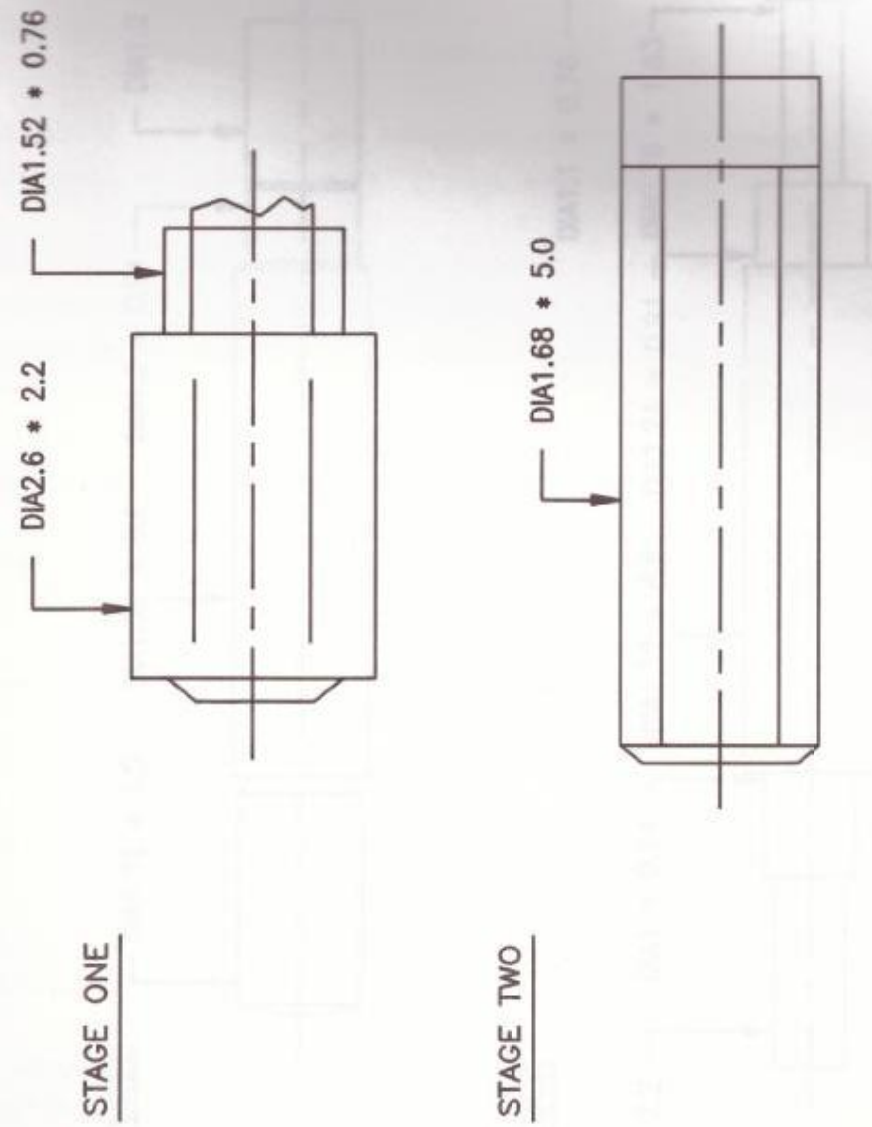
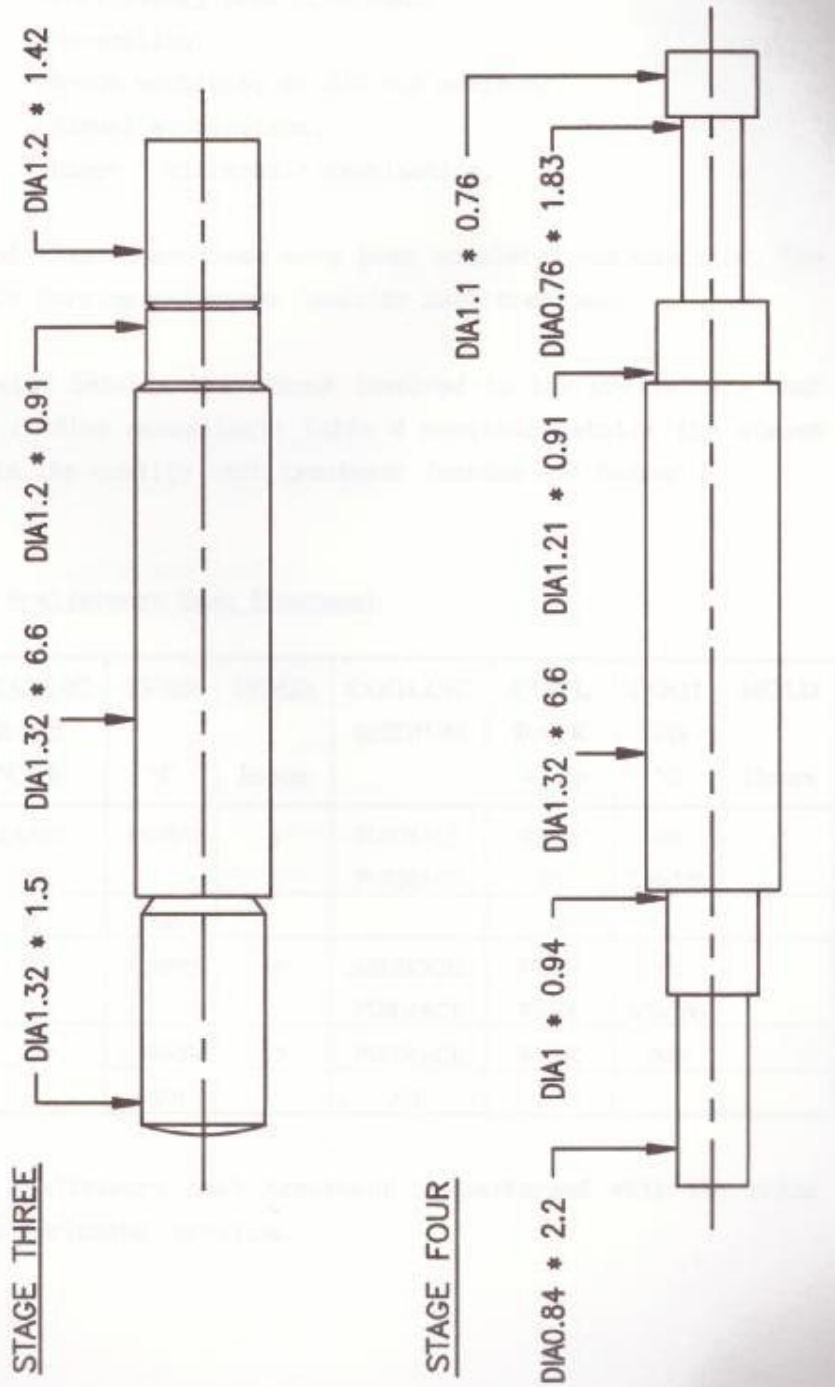


Figure 3B. Forging Process



3.3 HEAT TREATMENT

Following stage four of the forging process the rotor undergoes the following sequence of operations prior to quality heat treatment:

-Preliminary heat treatment;
-De-scaling;
-Rough machining to 250 cla maximum;
-Visual examination;
-Stage I ultrasonic examination.

When all of these operations have been completed successfully, the rotor shaft forging undergoes 'quality heat treatment'.

Table 3 below details the stages involved in the preliminary heat treatment (refine annealing); Table 4 overleaf details the stages involved in the quality heat treatment (harden and temper).

Table 3. Preliminary Heat Treatment

STAGE	HEATING RATE °C/Hr	TEMP °C	HOLD Hours	COOLING MEDIUM	COOL RATE °C/Hr	COOL TO °C	HOLD Hours
ONE	RAPID	830/870	6	FURNACE FURNACE	FREE 10	400 150/200	16
TWO	15	400					
THREE	60	915/935	16	AIR/BOGIE FURNACE	FREE FREE	400 150/200	
FOUR	15	630/650	25	FURNACE	FREE	300	
FIVE		AMB.		AIR			

The above preliminary heat treatment is performed with the rotor shaft in a horizontal position.

Table 4. Quality Heat Treatment

STAGE	HEATING RATE °C/Hr	TEMP °C	HOLD Hours	COOLING MEDIUM	COOL RATE °C/Hr	QUENCH TIME Hours	COOL TO °C
ONE	15	300					
TWO	60	830/850	14	WATER	-	7	50
THREE	LEVEL	150/200					
FOUR	15	400					
FIVE	60	595/605	24	FURNACE	10		300
SIX		AMB.		AIR			

The above quality heat treatment is performed with the rotor shaft suspended 'vertically'.

Subsequent to quality heat treatment, the following operations are performed on the rotor prior to despatch to GEC ALSTHOM:

-Mechanical Tests;
-Skim Machine all Peripheral Surfaces to 250 cla;
-Stage II Ultrasonic Examination;
-Machine and Bore to GEC ALSTHOM's drawing,
250 cla exterior and 63 cla bore;
-Stamp Cast No., Purchase Order No., etc.;
-Dimensional Examination;
-Stage III Ultrasonic Examination;
-Grease and Seal.

The finished rotor forging shaft must exhibit the following mechanical properties shown in Table 5 overleaf.

Table 5. Mechanical Properties Required of the Rotor Shaft

TEST	LONG.	RADIAL
0.2% Proof Stress (MPa)	770 to 900	
Ultimate Tensile Strength (MPa)	900 to 1010	
Reduction in Area (%)	40	30
Elongation (%)	14	12
FATT max. (°C)	/	-60
Impact (Joules) Average: Individual:	56 40	

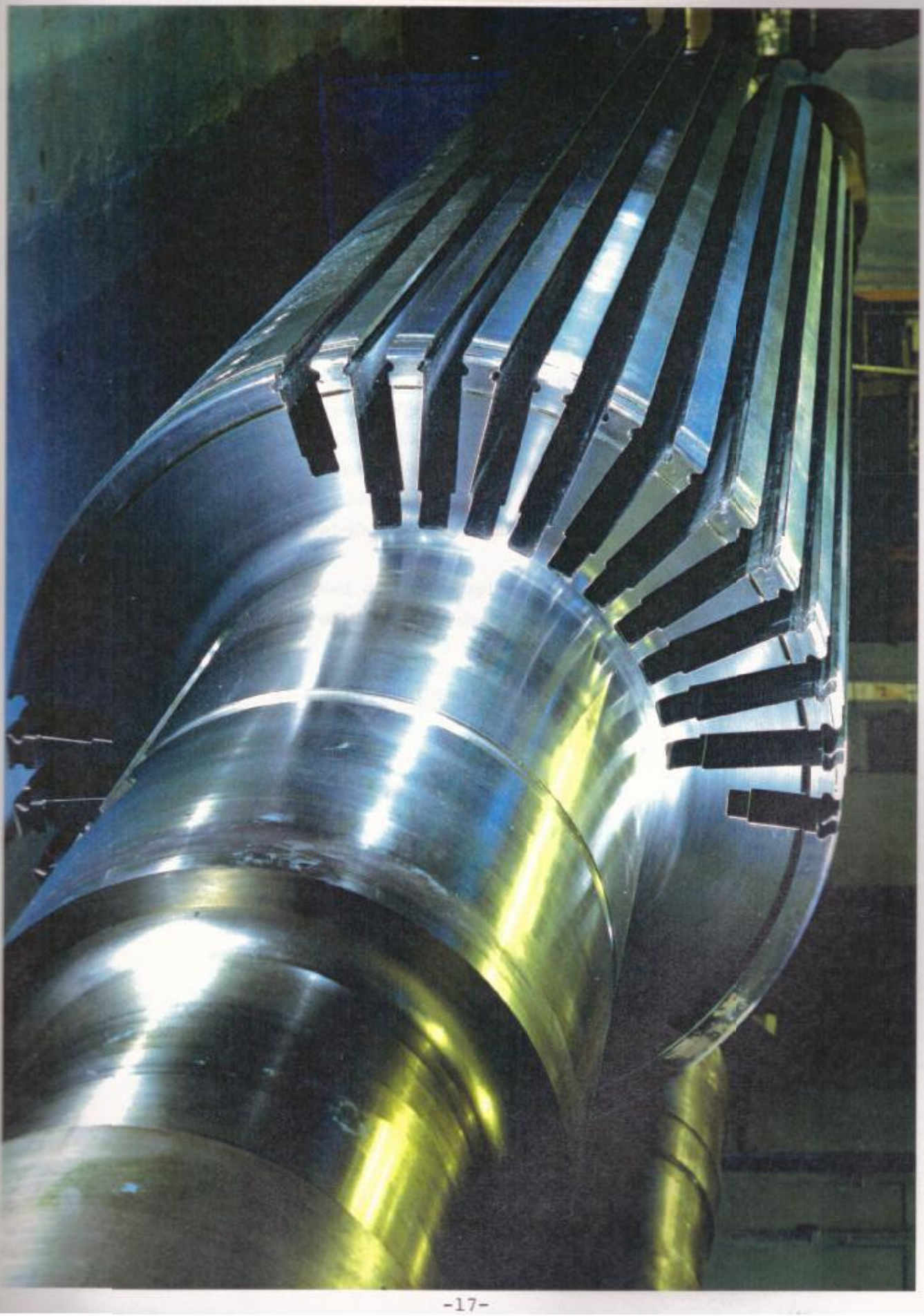
4.0 MANUFACTURE AT GEC ALSTHOM

This section concentrates on the main machining operations that are performed on the rotor shaft forging at GEC ALSTHOM. These are primary turning followed by milling of the axial slots and then further turning.

Further machining is carried out on the shaft such as shaft end drilling for the coupling equipment, but these will not be discussed here as they are relatively small operations compared to the milling and turning.

Figure 4 overleaf shows sectional detail of the axial slots machined into the rotor shaft forging.

Figure 4 Axial Slots



4.1 TURNING

Turning is the first manufacturing operation that is performed on the rotor shaft when it has been delivered to GEC ALSTHOM from the supplier. The rotor is in a basic pre-machined state with approximately 15mm of excess material left on all surfaces to be 'cleaned up'.

The bulk of the turning that is performed on the rotor shaft forgings at GEC ALSTHOM is done on large 2-axis lathes. All peripheral surfaces are finish machined in this operation. Single point cutting tools equipped with tungsten carbide inserts are used. Cutting speeds for the machining of the shaft are prescribed by the insert supplier, that is 100m/minute for the machining of Nickel-Chrome-Molybdenum-Vanadium low alloy steel.

The rotational speed of the workpiece and the feed of the cutting tool can then be calculated as described below.

ROTATIONAL SPEED OF WORKPIECE

$$N = \frac{1000 \times S}{\pi \times D}$$

$$= \frac{1000 \times 100}{\pi \times 1400}$$

$$\approx \underline{23 \text{ Revolutions / Minute}}$$

Where: N = Revolutions per Minute (R.P.M.)
S = Cutting Speed (mm / min)
D = Diameter of Workpiece (mm)

FEED RATE

$F = f \times N$

$= 21 \times 23$

$\approx$ 500 mm / minute

Where: F = Feed in mm (mm / min)

f = Feed per Revolution (mm / rev)

N = Rotational Speed of Workpiece (R.P.M.)

Relatively few problems are encountered in the turning stage of manufacture as relatively low metal removal rates are employed. More detail will be made of the milling stage of manufacture which is described in the next section of this report.

4.2 MILLING

The milling operations performed on the rotor shaft forging is the prime area where difficulties are encountered with the machining of particular contracts. The precise operation where the greatest difficulty occurs is the machining of the axial slots in the rotor body. Figures 5A and 5B on the following pages detail the eight stages that are involved in milling the full profile of these axial slots.

Stages 1 and 2 are termed the roughing stages of the rotor slot milling process, and this is where the bulk of the slot material is removed. The material is removed using 'wheel type cutters'; that is to say large (up to 40") diameter side and face category cutting tools which generate the profile required; the actual cutting edges comprise of indexable carbide inserts. The surface finish and diametrical accuracy is not particularly important during these stages. The priority here is a fast metal removal rate (MRR).

Stages 3, 4, 5, 6 and 8 are semi-finish and finishing processes. Again large diameter wheel type cutters are used, though this time the speed of revolution of the cutter is increased and the feed rate is decreased, this helps to obtain good dimensional accuracy and surface finish.

Stage 7 produces the dovetail profile near to the top of the rotor slot. This dovetail is achieved by running two smaller diameter wheel type cutters offset at the correct angle, down the length of the rotor slot, one leading the other.

Nearly all of the problems encountered are in the two roughing stages, where the emphasis is on MRR. There are relatively few problems in achieving good surface finish and dimensional accuracy which are the priority in the profile finish stages.

The speeds and feeds of the cutting tool are arrived at using the formulae detailed below. It must be noted that for each of the eight stages of the slot machining different speeds and feeds are employed. The speeds and feeds detailed below are employed in stage one of the slot machining of a typical rotor shaft.

ROTATIONAL SPEED OF CUTTER

$$N = \frac{1000 \times S}{\pi \times D}$$

$$= \frac{1000 \times 100}{\pi \times 800}$$

$$\approx \underline{40 \text{ Revolutions / Minute}}$$

Where: N = Revolutions per Minute (R.P.M.)
S = Cutting Speed (m / min)
D = Diameter of Cutter (mm)

FEEDRATE

$F = f \times n$

$= 0.7 \times 30$

$= \underline{21 \text{ mm / revolution}}$

$F = F \times N$

$= 21 \times 40$

$= \underline{840 \text{ mm / minute}}$

$M.R.R. = F \times d \times w$

$= 840 \times 90 \times 38$

$= \underline{2{,}892{,}800 \text{ mm}^3 \text{ / minute} \approx 1200\text{kg / hour}}$

Where: F = Feed per Revolution (mm / rev)
f = Feed per Tooth
n = No. of Teeth on Cutter
F = Feedrate (mm / min)
N = Rotational Speed of Cutter (R.P.M.)
d = Depth of Cut (mm)
w = Width of Cut (mm)
MR.R. = Metal Removal Rate (mm^3 / min)

The formulae detailed on the previous pages are only starting points for establishing the optimum cutting parameters, all of the speeds and feeds that are now employed in the machining of the rotor shafts have been derived empirically.

The machine on which rotors are machined is a large purpose built four-axis CNC machinining centre. Whenever a new rotor is received by the machinist, he will have a CNC program written for that job by the planning department. This program contains the speeds and feeds necessary to machine the rotor, and will have been calculated in the same fashion as the examples given previously. Once the machinist has started cutting the workpiece, however, he is responsible for ensuring that the job is being machined suitably and can adjust the speeds and feeds to whatever he feels to be appropriate.

Figure 5A. Slot Milling Processs

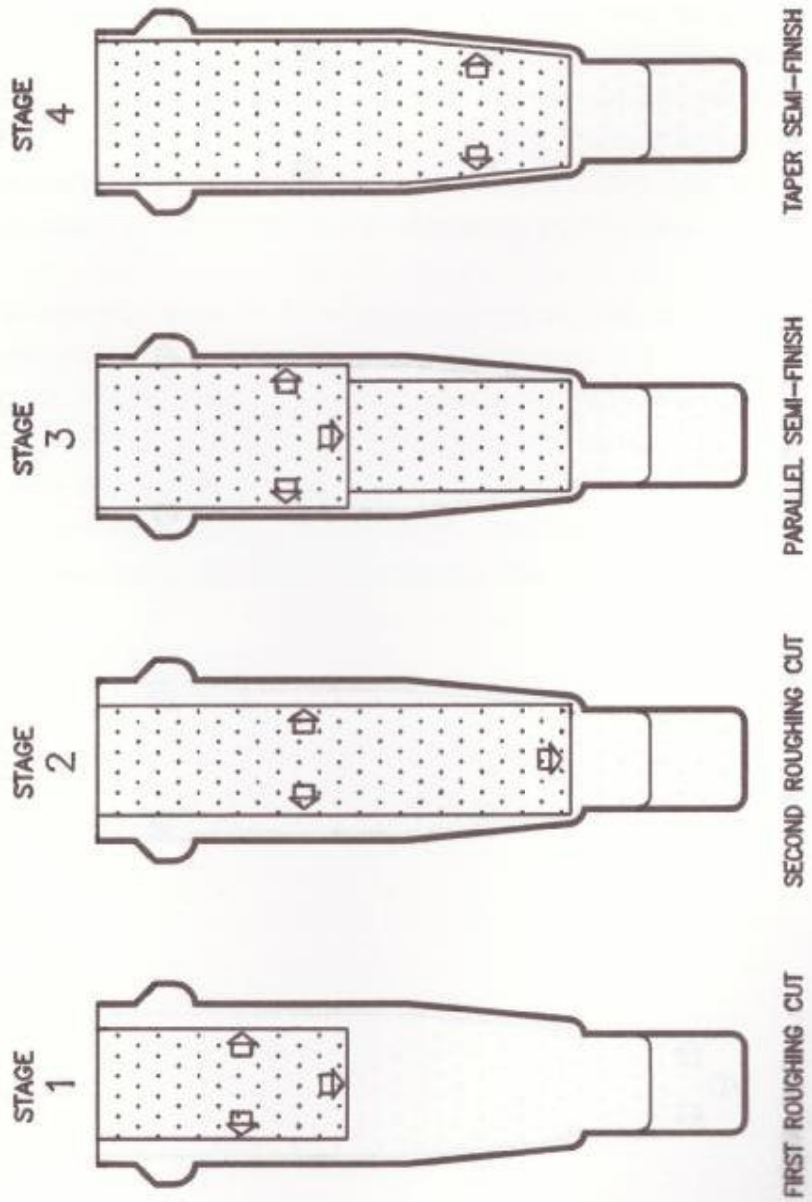
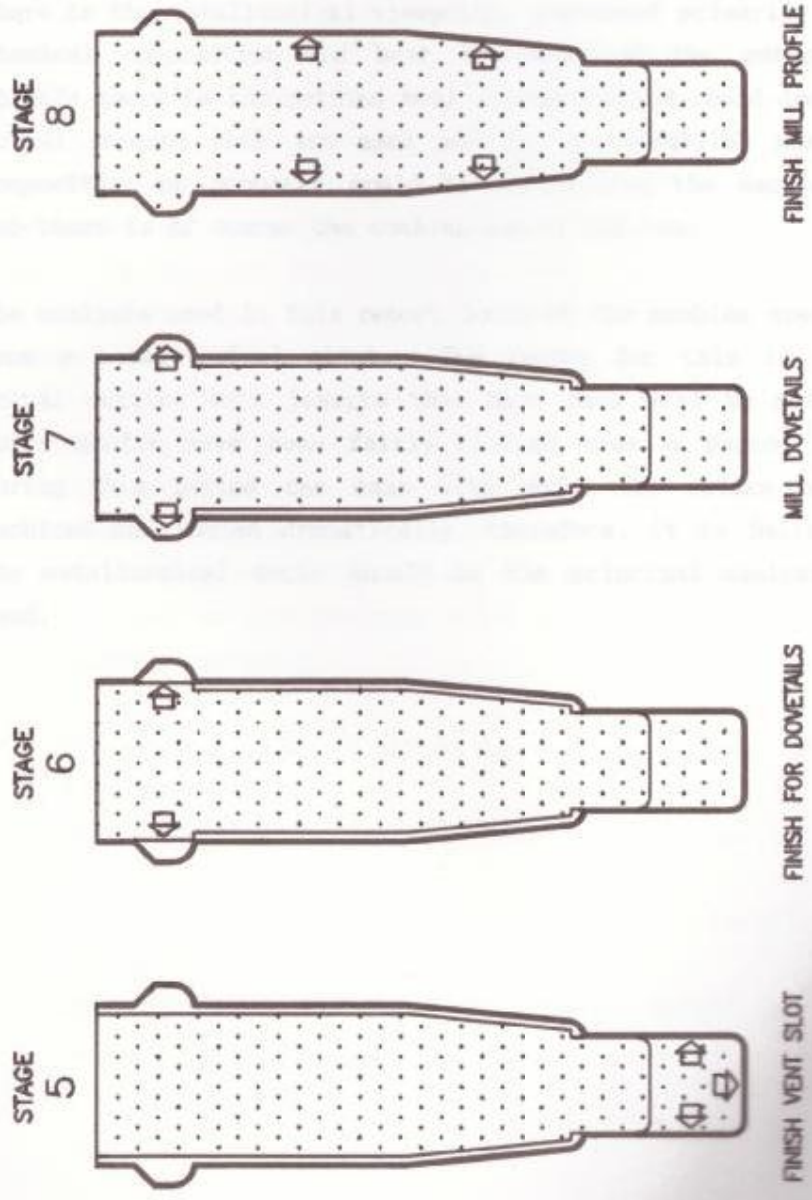


Figure 5B. Slot Milling Process



5.0 ANALYSIS METHOD EMPLOYED

There are many different approaches that could be taken in undertaking an investigation into the particular difficulties that are being encountered in the machining of the rotor shaft forging:-

There is the metallurgical viewpoint, concerned primarily with the chemical composition and heat treatment of the rotor forging itself; there is the cutting tool approach which could look at the actual inserts that are used and try to establish whether the composition or geometry could be influencing the machinability, and there is of course the combination of the two.

The analysis used in this report looks at the problem specifically from a metallurgical slant. The reason for this is that the actual cutting tool inserts that have been used to machine the rotor shafts have been fairly similar over a period of time. During this period the ease with which the rotors have been machined has varied dramatically, therefore, it is believed that the metallurgical angle should be the principal analysis to be used.

5.1 CORRELATION OF CONTRACTS

To enable any kind of analysis to be conducted, a great deal of background information needed to be collected. In the case of this analysis, the background information required was detailed chemical analysis and mechanical property reports of past rotor shaft forgings that have been machined at the factory.

I have been able to gather 86 of these reports for contracts that have been machined at GEC ALSTHOM. This done, it was necessary to identify which contracts proved to be difficult to machine and those that weren't. This proved to be more difficult than I first anticipated as it required a search through the manufacturing reports of all of the contracts for which I have obtained specifications and interpreting the production engineer's / operator's reports and comments.

To enable a quantitative approach to be taken to the analysis of the specifications, I have indicated the relative machinability of the different contracts by using a field called the *machinability key* or more simply the 'KEY' field for short. This is a numeric value assigned to each contract which can be either 0, 1, 2 or 3. These numbers represent:-

0 No reported difficulties in the machining of the rotor shaft forging;

1 Some machining difficulties that were overcome by reducing the feed rate, etc.;

2 Difficult to machine, many problems in the machining stage of manufacture of the rotor shaft;

3 Severely difficult to machine, drastic action was required to machine the rotor shaft.

The term difficult to machine encompasses several different situations which a production engineer / operator may describe as having caused problems. These situations could be 'bluing' of the rotor teeth due to excessive heat being generated during the cutting operation, excessive wear of the cutting tool inserts, poor chip formation causing the chip to 'stick' to the insert, and difficulty in obtaining a good surface finish. Although each of these situations could be attributed to different conditions in the rotor shaft, I have grouped them together for the purpose of this investigation.

5.2 DATABASE CONSTRUCTION

The database management software that I have used to perform the analysis for this project is the commercially available package dBASE IV v1.1 from Ashton-Tate. It is a flat-file database management tool that runs on the MS-DOS operating system on 'IBM PC compatible computers'.

The initial step taken when constructing the database was establishing which fields should be created. This was largely a case of deciding from the information which was available to me from the quality department, which fields were relevant to this investigation. For example, I have not included order numbers and drawing numbers in my database as they are not important in the context of this project.

The next step was to ensure that all of the attributes for the different contract records in any one field were in common units. As well as the data being in common units, it was important that all of the data in any one field was from tests pieces taken from the same position on the rotor shafts. Indeed all of the mechanical properties for the different contracts are from sample test pieces located at the 'ingot top end of the main body of the rotor shaft in a radial alignment'. All mechanical tests were conducted at a temperature of 20° C.

Entering the actual data entailed working through one record (contract) at a time and entering the attributes for each field within that record.

Once the database was completed I was able to manipulate the data by performing queries and indexes in ascending and descending order on different fields in the database to make trends in the data more obvious. For example, one query was performed on the KEY field of the database and the output presented in descending

numerical order to enable general trends to be observed in the different attributes affecting the machinability of the rotor shaft forging.

Many query reports were performed on the database and they are presented in Appendix A at the end of this report. Appendix B shows the program code required to construct a single query. I have also interpreted some of the results from the database outputs in a graphical form to make the trends even more obvious. These graphs are presented in further sections of this report.

A full list of all the fields used in the database are detailed in Table 6 overleaf.

The following notes explain some of the information in the database field list:

- The CONTRACT field refers to the customer who placed the order with GEC ALSTHOM for the rotor forging;

- The FORGE field refers to a unique forging number that is assigned to each rotor shaft that is purchased by GEC ALSTHOM;

- The DATE field refers to the date when the rotor shaft forgings was received by GEC ALSTHOM;

- The SUPPLIER field refers to name of the supplier who GEC ALSTHOM purchased the rotor shaft forging from;

- The values for each of the alloying elements refer to chemical composition by weight.

Table 6. Database Construction

FIELD NO.	FIELD	TYPE	UNITS	WIDTH
1	CONTRACT	CHARACTER	-	15
2	FORGING	NUMERIC	-	5
3	DATE	DATE	-	8
4	SUPPLIER	CHARACTER	-	12
5	KEY	NUMERIC	-	1
6	C	NUMERIC	-	4
7	SI	NUMERIC	-	4
8	MN	NUMERIC	-	4
9	S	NUMERIC	-	5
10	P	NUMERIC	-	5
11	NI	NUMERIC	-	4
12	CR	NUMERIC	-	4
13	MO	NUMERIC	-	4
14	V	NUMERIC	-	4
15	PROOF	NUMERIC	MPa	3
16	UTS	NUMERIC	MPa	3
17	ELONG	NUMERIC	%	2
18	ROFA	NUMERIC	%	2
19	HARDNESS	NUMERIC	H_V	3
20	IMPACT	NUMERIC	J	3
21	FATT	NUMERIC	°C	4

6.0 RESULTS

The results of the database queries are presented in tabular report form in Appendices One to Nine in the back of this report.

From these queries I have been able to infer certain trends or patterns with respect to the machinability of the different contracts, these are briefly as follows:-

1. Contracts with impact values higher than 170 Joules have all caused problems in machining; below 170 Joules there appears to little pattern to the effect of impact toughness on machinability.

2. Sulphur or phosphorus in isolation seem to have little effect on machinability.

3. There is a definite trend of a deterioration in machinability for contracts where the silicon content is below 0.08%. Indeed, as the silicon content gets near to 0.01% - 0.02%, the contracts become extremely difficult to machine.

4. There appears to be a trend for contracts low in manganese being easier to machine, however, this could be a superficial observation since the lower manganese content also seems to correspond to a higher silicon content.

5. No correlation can be observed between tensile strength and machinability.

6. There are definite trends between the rotor forging supplier and machinability. For example, all forgings supplied by Mitsui in Japan have proved difficult to machine. This can be partly explained by the fact that their rotor forging steel tends to be very 'clean' and possesses high mechanical properties.

A fuller interpretation of these findings will be detailed in the discussion section of this report.

7.0 DISCUSSION

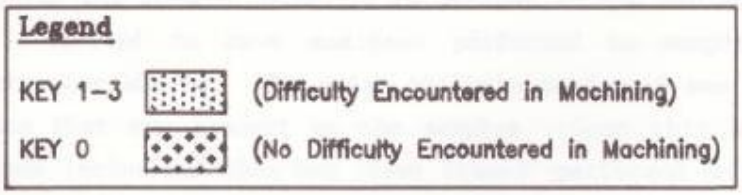
It is clear from the analysis performed to understand the effect that the different chemical compositions and mechanical properties have on the machinability of the rotor shaft forgings that the major influencing factor is the amount of silicon present in the steel.

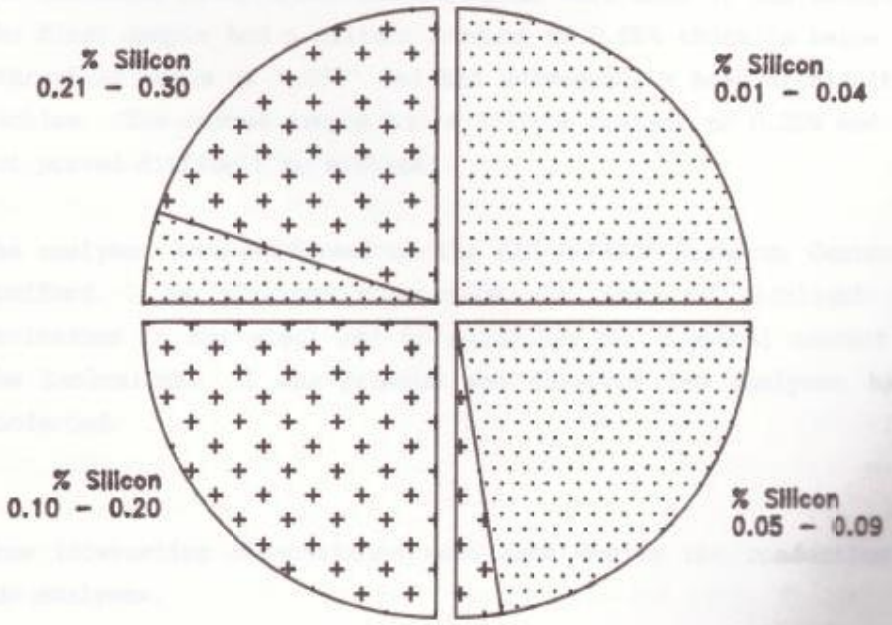
It was observed that when the silicon content of the rotor shaft falls below 0.10% there is a sharp deterioration in machinability, as defined by rapid wear of machining inserts, excessive generation of heat in the rotor teeth, etc. A graphical interpretation emphasising the detrimental effect of low silicon content on the machinability of the rotor shaft is shown on the following page in Figure 6.

Silicon, along with sulphur, phosphorus, and manganese are regarded as undesirable elements, or 'impurities' in steel. They have little effect on the mechanical properties of the rotor shaft, but are there as a 'by-product' of the steelmaking process. The general intention of the suppliers of the rotor forging is to reduce the amount of these impurities to a minimum, that is to create a 'clean' steel. However, it can be seen that this is not the ideal condition for the rotor shaft from a machining point of view.

Silicon in relatively small amounts, i.e. up to 0.50% composition by weight, is not generally regarded as having a significant effect on the machinability of steel. Most research tends to point the finger towards sulphur and manganese, present in the form of manganese sulphide inclusions, as being the chief influences on machinability. It is widely recognised that in general, as the sulphur content of the steel decreases, the steel becomes more difficult to machine[1].

Figure 6. Variation of Silicon with KEY





Silicon can be present in two forms in the steel:-

i) It can go into solid solution in ferrite, in which case it strengthens the matrix[2].

ii) It can precipitate out under oxidising conditions and be present as silicate, or SiO_2[3].

To establish the form in which it is present in GEC ALSTHOM rotor shafts I decided to have analyses performed on samples from different rotor shafts. The prime analysis performed was to find inclusions that are present in the samples. Once this had been done, these inclusions then had 'line traces' performed on them on an electron probe micro-analyser to establish the silicon, sulphur and manganese contents across the inclusion. The 'hard copy' outputs from these analyses are contained in Appendix C.

Two different rotor shaft steel samples were used in the analyses. The first sample had a silicon content of 0.05% which is below the 'threshold value of 0.08%' and had subsequently been difficult to machine. The second sample had a silicon content of 0.22% and had not proved difficult to machine.

The analyses were performed at the GEC ALSTHOM Research Centre in Stafford. An electron microscope was used to highlight the inclusions in the steel and to establish the chemical content of the inclusions. I was present and observed the analyses being conducted.

Some interesting observations were made during the conduction of the analyses.

i). In the sample with 0.05% silicon content, it was not possible to find any inclusions that were high in silicon. Nearly

all of the inclusions that could be found were high in manganese and sulphur: manganese sulphides.

ii). In the sample with a silicon content of 0.22%, many of the inclusions that were present in the steel were high in silicon, perhaps as many as 50% of the inclusions, most of the other inclusions were manganese sulphides.

From these observations, and consultation with the laboratory research technicians, I have drawn the following conclusions:

1. When silicon is present in the steel in very small quantities, in this case below approximately 0.10%, it all goes into solid solution in the ferrite.

2. When silicon is present in the steel in larger quantities than 0.10%, the increased silicon content is present in the form of silicate inclusions.

The logical conclusion then, for the fact that an increase in silicon content correlates to an increase in the machinability of the rotor shaft, is that the 'extra silicon' is present as hard but brittle silicate inclusions. These have the effect of breaking up the chip generated during the metal cutting operation causing less heat to be generated. They also reduce the occurrence of built-up-edge (BUE); the build up of residual chips, which have already been machined off the workpiece. Initially, this BUE has a positive effect on the machinability due to it reducing friction between the workpiece and cutting tool interface. However, when the BUE becomes too large, the shear zone becomes too far removed from the cutting edge of the tool causing the cutting force required to shear the workpiece to increase rapidly and ultimately causing the fracture of the cutting tool insert[4].

OTHER CONCLUSIONS

As well as the central cause of the machinability problems being attributed to the silicon content, I have been able to draw other conclusions from the investigation.

i) Contracts with impact toughness values higher than 170 Joules have all caused problems in machining; below 170 Joules there appears to be little direct relationship between toughness and machinability. It would be expected that a high toughness steel would prove difficult to machine due to 'plastic shear', or tearing, at the cutting tool/workpiece interface, meaning that higher cutting forces are needed. Allied to this is the excess heat that this plastic shear generates.
Although it is clear that high toughness makes the rotor shaft more difficult to machine, it is not a problem as such since it would not be a good idea to reduce the toughness value just to facilitate machinability. At present, there is a good deal of liaison with our cutting tool suppliers to find inserts that will be able to cope with the increased toughness of the workpieces.

ii) It is clear that rotor shaft forgings from certain suppliers are more difficult to machine than others. The rotors supplied by Krupp, Mitsui and Terni have all caused problems. This can be explained by the fact that these suppliers achieve a cleaner steel than GEC ALSTHOM's other suppliers, by cleaner I mean lower sulphur, silicon, manganese and phosphor contents.
An observation I picked up from the manager of the machine shop at Forgemasters Engineering in Sheffield is "the more muck in the steel the better it is to machine."

iii) The database queries show no other patterns among the mechanical properties and chemical elements within the steel having an effect on the rotor shaft's machinability. It might have been expected that a trend would appear with regard to the effect of the sulphur content on the machinability of the steel,

but this wasn't so. It might also be expected that there would be a trend with regard to the ductility of the steel but there certainly appeared to be no correlation between the percentage elongation or reduction of area and KEY.

It is clear from this discussion that the silicon content is the prime factor to be addressed if an improvement in the machinability of the rotor shaft forging is to achieved.

8.0 CONCLUSIONS

It is clear from the investigation that I have performed that low silicon content in the steel, specifically a content below 0.10%, is the main cause of the problems in the machining of the rotor shaft forging at GEC ALSTHOM. The obvious conclusion to draw from this is to ensure that the silicon content of rotor shaft steel be above 0.10%. This is not a simple option to adopt however, due to modern advances in achieving clean steels.

All suppliers of rotor shafts for GEC ALSTHOM produce the steel using electric arc furnaces. GEC ALSTHOM specifies that secondary refining of the steel should be introduced by de-gassing the steel under vacuum. This is achieved by introducing carbon under vacuum, this reacts with the trace elements/impurities and reduces their levels in the steel significantly. Silicon levels below 0.02% are achievable. Hence, to specify a silicon content above 0.10%, the silicon needs to be added to the steel by a process called re-siliconization. This extra process adds cost to the rotor shaft.

Despite these extra costs incurred during the steelmaking stage of manufacture, increasing the silicon content of the steel is presently the best method available for increasing the machinability of the rotor shaft. The costs incurred from delays in manufacture at GEC ALSTHOM due to machining problems are significantly higher than the additional cost from the re-siliconization at the steelmaking stage. All rotor shafts purchased by GEC ALSTHOM will now specify silicon contents greater than 0.10%.

Further research needs to be conducted into the difficulties, and these are to be directed primarily to the machinability aspect rather than metallurgical. Development of more suitable cutting tool inserts and cutting tools appear to hold the key to finally

overcoming the problems, rather than getting around them. I have initiated discussion with our cutting tool insert suppliers and they are preparing a specification for an effort in addressing the situation and coming up with suitable alternative inserts.

SUMMARY OF APPENDICES

APPENDIX A

DATABASE QUERY REPORTS

FULL DATABASE REPORT LISTING

Indexed on Forging Number Sheet 1 of 2

CONTRACT	SUPPLIER	FORGE	DATE	KEY	C	NI	CR	MO	V	SI	S	P	MN	PRF	BA	IMP	FATT
GRAIN1	BSC	18038	04/01/72	0	0.21	3.42	1.47	0.50	0.10	0.10	0.009	0.008	0.20	850	66	107	-50
KILROOT	RHEINSTAHL	18606	21/12/72	0	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007	0.35	630	59	86	-10
GRANGEMOUTH	RHEINSTAHL	18607	21/12/72	0	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007	0.35	620	60	82	-70
TSING YI	GOLODETZ	18655	10/12/73	0	0.37	2.90	1.32	0.35	0.12	0.29	0.013	0.011	0.41	770	62	0	999
GRAIN5	BSC	18679	23/07/73	0	0.27	3.55	1.40	0.40	0.14	0.12	0.008	0.009	0.33	741	69	114	-83
KIPEVU7	FRIED KRUPP	18960	23/07/73	2	0.28	2.00	1.34	0.47	0.10	0.07	0.012	0.010	0.43	657	70	75	-10
LITTLEBROOK2	ROCHLING	19004	24/07/75	0	0.27	2.08	1.22	0.36	0.15	0.11	0.011	0.008	0.22	610	72	148	-40
ABADAN	BSC	19019	11/10/73	0	0.30	2.00	1.26	0.40	0.11	0.12	0.010	0.007	0.19	585	75	163	-20
PETERHEAD1	BSC	19042	28/01/74	0	0.28	3.47	1.46	0.40	0.14	0.20	0.006	0.008	0.34	770	71	110	-64
MEI BHOPAL	COCHERILL	19052	01/04/74	0	0.26	1.80	1.17	0.41	0.00	0.25	0.016	0.018	0.47	650	72	108	999
INCE6	ROCHLING	19128	22/10/73	0	0.28	2.05	1.21	0.43	0.13	0.10	0.014	0.006	0.23	640	69	167	-20
STOCK9	GOLODETZ	19129	22/10/73	2	0.36	3.11	1.26	0.37	0.13	0.27	0.016	0.010	0.42	700	66	147	40
KILROOT1	GOLODETZ	19190	30/01/74	0	0.24	3.24	1.46	0.38	0.11	0.29	0.010	0.012	0.41	635	75	167	10
SUNDANCE5	BSC	19290	31/01/74	0	0.30	3.35	1.50	0.40	0.12	0.20	0.006	0.007	0.20	695	74	143	-95
QUAD OLYMPUS1	BSC	19326	01/07/74	0	0.27	1.80	1.31	0.42	0.10	0.23	0.008	0.009	0.23	570	71	107	-55
AHWAZ2	GOLODETZ	19376	04/02/74	0	0.37	3.06	1.33	0.38	0.12	0.29	0.011	0.012	0.32	695	67	94	30
KILROOT3	BSC	19377	30/01/74	0	0.30	1.90	1.25	0.38	0.09	0.35	0.008	0.008	0.17	695	71	130	-57
BLYTH8	BSC	19593	05/07/74	0	0.27	1.85	1.35	0.40	0.09	0.23	0.006	0.008	0.20	660	75	143	-77
GRAIN4	GOLODETZ	19699	27/06/74	0	0.36	3.06	1.23	0.39	0.12	0.28	0.014	0.014	0.38	695	64	118	999
KILROOT4	BSC	19724	26/02/74	0	0.26	1.94	1.24	0.42	0.11	0.08	0.007	0.017	0.16	585	75	150	-89
GRANGEMOUTH2	FRIED KRUPP	19725	21/08/74	0	0.29	1.95	1.42	0.43	0.10	0.13	0.012	0.008	0.38	669	66	90	-35
COTTAM3	FRIED KRUPP	20091	10/12/74	2	0.30	2.09	1.43	0.44	0.09	0.06	0.009	0.007	0.39	665	69	176	-120
NATIONAL SPARE	FRIED KRUPP	20194	18/03/75	2	0.26	3.46	1.40	0.45	0.08	0.03	0.008	0.008	0.40	860	66	86	-70
DUVHA1	BSC	20348	23/04/75	0	0.25	3.48	1.48	0.41	0.13	0.18	0.006	0.005	0.14	725	74	130	-90
DUVHA2	THYSSEN	20349	23/04/75	0	0.26	3.31	1.65	0.43	0.11	0.17	0.008	0.008	0.28	745	71	116	-100
LITTLEBROOK3	GOLODETZ	20422	22/08/75	2	0.38	2.86	1.33	0.39	0.13	0.35	0.015	0.017	0.38	650	51	75	25
SUNDANCE6	BSC	20692	11/03/76	0	0.28	3.46	1.44	0.41	0.13	0.18	0.008	0.007	0.26	710	74	138	-105
DUVHA3	BSC	20712	05/04/76	0	0.30	3.47	1.46	0.40	0.12	0.17	0.009	0.011	0.22	785	66	113	-90
ESCOM SPARE	ROCHLING	20855	10/01/77	0	0.28	3.50	1.67	0.42	0.11	0.08	0.006	0.009	0.22	732	74	125	-100
DUVHA4	BSC	20858	26/01/77	0	0.29	3.50	1.43	0.40	0.12	0.16	0.005	0.006	0.25	787	70	141	-87
KORI2	MITSUI	20865	07/02/77	3	0.26	3.42	1.67	0.44	0.10	0.02	0.008	0.007	0.25	755	67	196	-88
NIGERIA	ROCHLING	20914	21/04/77	0	0.26	2.00	1.31	0.42	0.10	0.08	0.013	0.005	0.21	623	70	88	-44
EM610STOCKC	TERNI	21008	27/07/77	2	0.25	2.30	1.34	0.47	0.10	0.06	0.009	0.008	0.35	670	73	186	-74
EM610STOCK10	KRUPP	21010	04/08/77	2	0.26	1.94	1.42	0.43	0.09	0.06	0.012	0.007	0.41	643	70	120	-79
ELM150	KRUPP	21016	27/06/77	2	0.26	1.96	1.34	0.42	0.12	0.06	0.011	0.010	0.40	656	71	155	-40
EM610BSTOCK8C	BSC	21032	10/05/77	2	0.28	1.84	1.24	0.37	0.09	0.24	0.009	0.003	0.18	650	72	126	-35
DUVHA5	THYSSEN	21033	11/07/77	0	0.29	3.40	1.71	0.42	0.11	0.10	0.009	0.007	0.28	748	71	112	-110
NIGERIAN NEWS	ROCHLING	21039	26/05/77	0	0.26	2.05	1.33	0.40	0.09	0.08	0.010	0.005	0.33	593	73	125	-60
EM610CSTOCK11	KRUPP	21236	10/10/77	3	0.32	1.93	1.37	0.43	0.09	0.03	0.010	0.006	0.36	650	70	94	-55
CASTLE PEAK	KRUPP	21351	16/01/78	1	0.25	3.42	1.59	0.31	0.10	0.06	0.010	0.005	0.24	662	74	165	999
BERYL1	FRIED KRUPP	21420	13/04/78	2	0.25	1.92	1.41	0.42	0.09	0.03	0.009	0.011	0.35	598	73	112	999
KEEPHILLS3	BSC	21458	16/06/78	0	0.28	3.40	1.40	0.40	0.11	0.13	0.008	0.005	0.22	772	73	146	-122
EM610STOCK13	BSC	21459	16/12/77	0	0.29	1.94	1.29	0.42	0.08	0.18	0.010	0.006	0.40	650	72	95	-90
NUCLEAR5	MITSUI	21485	29/03/78	1	0.25	3.49	1.59	0.43	0.13	0.06	0.006	0.006	0.27	745	71	135	-95
NUCLEAR6	MITSUI	21567	03/07/78	3	0.24	3.43	1.62	0.43	0.12	0.01	0.008	0.005	0.25	700	75	210	-100
EM610STOCK12	BSC	21628	07/11/78	0	0.28	1.91	1.24	0.43	0.08	0.19	0.008	0.008	0.27	695	72	103	-53
DRAX.COMPL1	BSC	21667	14/09/78	0	0.29	1.92	1.25	0.45	0.11	0.23	0.007	0.008	0.36	710	74	117	-80
DRAX.COMPL3	TERNI	21668	15/09/78	1	0.24	2.03	1.57	0.45	0.10	0.06	0.008	0.005	0.47	661	75	196	-80
CASTLE PEAK2	BSC	21710	15/12/78	0	0.28	3.48	1.43	0.40	0.11	0.14	0.007	0.007	0.23	815	68	141	-100
CASTLE PEAK3	BSC	21779	09/04/79	1	0.26	3.43	1.40	0.42	0.10	0.06	0.009	0.008	0.27	828	65	102	999
EM610STOCK14	BSC	21795	20/04/79	0	0.30	1.88	1.23	0.41	0.09	0.22	0.006	0.006	0.23	675	70	128	-66
EM610STOCK15B	FRIED KRUPP	21796	20/04/79	2	0.28	1.90	1.35	0.42	0.10	0.04	0.010	0.005	0.32	675	72	114	-70
EM610STOCK3	VON ROLL	21922	09/04/79	0	0.27	1.92	1.27	0.36	0.10	0.11	0.001	0.007	0.36	692	69	92	999

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CONTRACT	SUPPLIER	FORGE	DATE	KEY	C	NI	CR	MO	V	SI	S	P	MN	PRF	RA	IMP	FATT
EM610STOCK9	VON ROLL	21999	09/04/79	2	0.25	2.01	1.32	0.40	0.10	0.04	0.003	0.010	0.32	678	65	82	999
DUVHA6	TERNI	22065	08/05/79	1	0.25	3.49	1.34	0.44	0.11	0.06	0.007	0.007	0.29	700	73	131	-80
ELM MOBILE	FRIED KRUPP	22078	06/06/79	0	0.29	3.42	1.42	0.42	0.10	0.12	0.007	0.009	0.30	701	59	120	-90
CASTLE PEAK4	FRIED KRUPP	22291	07/03/80	2	0.27	3.43	1.42	0.45	0.09	0.03	0.008	0.006	0.29	777	72	108	-90
TUTUKA1	THYSSEN	22516	06/06/80	1	0.27	3.68	1.74	0.41	0.11	0.05	0.008	0.008	0.31	721	71	103	-85
TUTUKA2	BSC	22527	17/07/80	0	0.28	3.46	1.45	0.36	0.11	0.11	0.009	0.006	0.39	745	72	109	-117
STOCK	TERNI	22528	21/07/80	2	0.24	3.56	1.40	0.42	0.10	0.04	0.008	0.007	0.35	748	72	143	-120
TORNESS1	BSC	22671	01/08/80	0	0.27	3.46	1.43	0.41	0.11	0.15	0.010	0.010	0.38	790	72	102	-102
TUTUKA3	TERNI	22691	30/03/81	2	0.24	3.45	1.47	0.39	0.10	0.02	0.006	0.007	0.34	728	73	138	-136
CASTLE PEAK5	BSC	22692	09/04/81	0	0.26	3.49	1.45	0.41	0.12	0.15	0.007	0.008	0.20	780	70	137	-105
BANGLADESH	ITALSIDER	22698	22/05/81	0	0.25	1.89	1.31	0.39	0.09	0.26	0.007	0.008	0.42	656	69	99	999
STOCK	FRIED KRUPP	22920	24/09/80	1	0.29	1.93	1.46	0.45	0.11	0.09	0.012	0.009	0.44	675	73	120	-90
TUTUKA4	TERNI	22929	24/09/81	2	0.24	3.45	1.38	0.37	0.09	0.03	0.007	0.008	0.28	709	69	147	-121
HINKLEY POINT	THYSSEN	22932	07/10/81	2	0.27	3.60	1.70	0.42	0.12	0.05	0.007	0.007	0.27	750	67	123	999
GENESSEE2	CREUSOT-LOIR	23058	13/01/82	0	0.29	3.62	1.66	0.41	0.12	0.10	0.006	0.005	0.30	780	65	137	-101
TORNESS2	BSC	23075	11/11/81	0	0.28	3.52	1.55	0.42	0.12	0.12	0.007	0.007	0.21	770	72	122	-105
TRINIDAD1	FRIED KRUPP	23091	14/01/82	0	0.26	3.48	1.41	0.46	0.10	0.13	0.011	0.007	0.32	719	72	132	-57
WILLINGTON	BSC	23121	26/02/82	0	0.27	3.52	1.44	0.41	0.13	0.17	0.005	0.005	0.24	695	72	141	-105
ADMIR'Y	BSC	23197	25/05/82	1	0.26	3.50	1.47	0.46	0.13	0.05	0.005	0.008	0.32	695	75	155	-100
ADYSS	BSC	23224	25/05/82	0	0.28	3.43	1.44	0.36	0.13	0.18	0.005	0.004	0.21	745	70	98	-114
RIHAND1	BSC	23300	02/11/82	0	0.25	3.41	1.47	0.42	0.11	0.15	0.006	0.005	0.39	735	68	147	-106
RINGHALS	BSC	23323	11/10/82	0	0.28	3.49	1.49	0.38	0.14	0.10	0.006	0.007	0.25	710	74	147	-100
MARATHON BRAE	BSC	23421	24/11/82	0	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004	0.30	770	73	99	-90
BRITOIL	BSC	23422	24/11/82	0	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004	0.30	710	74	91	-100
CASTLE PEAK2	BSC	23428	12/10/82	0	0.25	3.46	1.43	0.44	0.13	0.14	0.009	0.006	0.20	785	72	132	-107
TUTUKA5	TERNI	23500	18/10/82	1	0.26	3.53	1.49	0.41	0.10	0.06	0.006	0.006	0.30	723	73	157	-115
TUTUKA6	FORGEM	23527	19/10/82	0	0.26	3.51	1.50	0.41	0.11	0.13	0.009	0.005	0.21	740	72	103	-120
HIGH SPEED M	POMAS	23659	01/11/82	0	0.38	3.50	1.80	0.44	0.11	0.27	0.007	0.010	0.28	750	64	84	-71
MARATHON BRAE2	FORGEM	23661	25/03/83	0	0.25	3.55	1.48	0.37	0.11	0.14	0.008	0.007	0.22	680	77	102	-113
MARATHON BRAE3	FORGEM	23682	25/03/83	0	0.30	3.45	1.42	0.36	0.10	0.11	0.007	0.005	0.19	750	72	88	-121
CASTLE PEAK3	FORGEM	23825	04/11/83	0	0.27	3.49	1.50	0.43	0.12	0.19	0.006	0.005	0.25	730	70	121	-89
DIDCOT	FORGEM	30439	29/06/92	0	0.25	3.52	1.56	0.42	0.12	0.11	0.008	0.006	0.24	817	70	77	999
PEM1	CREUSOT-LOIR	99999	20/11/91	3	0.23	3.52	1.84	0.35	0.10	0.01	0.012	0.009	0.28	792	68	119	999

End of Report

REPORT INDEXED ON KEY

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CONTRACT	FORGE	KEY	C	NI	CR	MO	V	SI	S	P	MN	PRF	RA	IMP	FATT
NUCLEAR6	21567	3	0.24	3.43	1.62	0.43	0.12	0.01	0.008	0.005	0.25	700	75	210	-100
FEM1	99999	3	0.23	3.52	1.84	0.35	0.10	0.01	0.012	0.009	0.28	792	68	119	999
KORI2	20865	3	0.26	3.42	1.67	0.44	0.10	0.02	0.008	0.007	0.25	755	67	196	-88
EM610CSTOCK11	21236	3	0.32	1.93	1.37	0.43	0.09	0.03	0.010	0.006	0.36	650	70	94	-55
TUTUKA3	22691	2	0.24	3.45	1.47	0.39	0.10	0.02	0.006	0.007	0.34	728	73	138	-136
TUTUKA4	22929	2	0.24	3.45	1.38	0.37	0.09	0.03	0.007	0.008	0.28	709	69	147	-121
NATIONAL SPARE	20194	2	0.26	3.46	1.40	0.45	0.08	0.03	0.008	0.008	0.40	860	66	86	-70
CASTLE PEAK4	22291	2	0.27	3.43	1.42	0.45	0.09	0.03	0.008	0.006	0.29	777	72	108	-90
BERYL1	21420	2	0.25	1.92	1.41	0.42	0.09	0.03	0.009	0.011	0.35	598	73	112	999
STOCK	22528	2	0.24	3.56	1.40	0.42	0.10	0.04	0.008	0.007	0.36	748	72	143	-120
EM610STOCK9	21999	2	0.25	2.01	1.32	0.40	0.10	0.04	0.003	0.010	0.32	678	65	82	999
EM610STOCK15B	21796	2	0.28	1.90	1.35	0.42	0.10	0.04	0.010	0.005	0.32	675	72	114	-70
HINKLEY POINT	22932	2	0.27	3.60	1.70	0.42	0.12	0.05	0.007	0.007	0.27	750	67	123	999
EM610STOCK10	21010	2	0.26	1.94	1.42	0.43	0.09	0.06	0.012	0.007	0.41	643	70	120	-79
ELM150	21016	2	0.26	1.96	1.34	0.42	0.12	0.06	0.011	0.010	0.40	656	71	155	-40
EM610STOCKC	21008	2	0.25	2.30	1.34	0.47	0.10	0.06	0.009	0.008	0.55	670	73	186	-74
COTTAM3	20091	2	0.30	2.09	1.43	0.44	0.09	0.06	0.009	0.007	0.39	665	69	176	-120
KIPEVU7	18960	2	0.28	2.00	1.34	0.47	0.10	0.07	0.012	0.010	0.43	657	70	75	-10
EM610BSTOCK8C	21032	2	0.28	1.84	1.24	0.37	0.09	0.24	0.009	0.003	0.18	650	72	126	-35
STOCK9	19129	2	0.36	3.11	1.26	0.37	0.13	0.27	0.016	0.010	0.42	700	66	147	40
LITTLEBROOK3	20422	2	0.38	2.86	1.33	0.39	0.13	0.35	0.015	0.017	0.38	650	51	75	25
TUTUKA1	22516	1	0.27	3.68	1.74	0.41	0.11	0.05	0.008	0.008	0.31	721	71	103	-85
ADMIR'Y	23197	1	0.26	3.50	1.47	0.46	0.13	0.05	0.005	0.008	0.32	695	75	155	-100
DUVHA6	22065	1	0.25	3.49	1.34	0.44	0.11	0.06	0.007	0.007	0.29	700	73	131	-80
CASTLE PEAK3	21779	1	0.26	3.43	1.40	0.42	0.10	0.06	0.009	0.008	0.27	828	65	102	999
TUTUKA5	23500	1	0.26	3.53	1.49	0.41	0.10	0.06	0.006	0.006	0.30	723	73	157	-115
DRAX.COMPLB	21668	1	0.24	2.03	1.57	0.45	0.10	0.06	0.008	0.005	0.47	665	75	196	-80
NUCLEAR5	21485	1	0.25	3.49	1.59	0.43	0.13	0.06	0.006	0.006	0.27	745	71	235	-95
CASTLE PEAK	21351	1	0.25	3.42	1.59	0.31	0.10	0.06	0.010	0.005	0.24	662	74	165	999
STOCK	22920	1	0.29	1.93	1.46	0.45	0.11	0.09	0.012	0.009	0.44	675	73	120	-90
ESCOM SPARE	20855	0	0.28	3.50	1.67	0.43	0.11	0.08	0.006	0.009	0.22	732	74	125	-100
KILROOT4	19724	0	0.26	1.94	1.24	0.42	0.11	0.08	0.007	0.017	0.16	585	75	150	-89
NIGERIA	20914	0	0.26	2.00	1.31	0.42	0.10	0.08	0.013	0.005	0.21	623	70	88	-44
NIGERIAN NEWS	21039	0	0.26	2.05	1.33	0.40	0.09	0.08	0.010	0.005	0.23	593	73	125	-60
RINGHALS	23323	0	0.28	3.49	1.49	0.38	0.14	0.10	0.006	0.007	0.25	710	74	147	-100
GENESSEE2	23058	0	0.29	3.62	1.66	0.41	0.12	0.10	0.006	0.005	0.30	780	65	137	-101
DUVHA5	21033	0	0.29	3.40	1.71	0.42	0.11	0.10	0.009	0.007	0.28	748	71	112	-110
INCE6	19128	0	0.28	2.05	1.21	0.43	0.13	0.10	0.014	0.006	0.23	640	69	167	-20
GRAIN1	18038	0	0.21	3.42	1.47	0.50	0.10	0.10	0.009	0.008	0.20	850	66	107	-50
LITTLEBROOK2	19004	0	0.27	2.08	1.22	0.36	0.15	0.11	0.011	0.008	0.22	610	72	148	-40
EM610STOCK8	21922	0	0.27	1.92	1.27	0.36	0.10	0.11	0.001	0.007	0.36	692	69	92	999
TUTUKA2	22527	0	0.28	3.46	1.45	0.36	0.11	0.11	0.009	0.006	0.19	745	72	109	-117
DIDCOT	30439	0	0.25	3.52	1.56	0.42	0.12	0.11	0.008	0.006	0.24	817	70	77	999
MARATHON BRAE3	23682	0	0.30	3.45	1.42	0.36	0.10	0.11	0.007	0.005	0.19	750	72	88	-121
GRAIN5	18679	0	0.27	3.55	1.40	0.40	0.14	0.12	0.008	0.009	0.33	741	69	114	-83
TORNESS2	23075	0	0.28	3.52	1.55	0.42	0.12	0.12	0.007	0.007	0.21	770	72	122	-105
ABADAN	19019	0	0.30	2.00	1.26	0.40	0.11	0.12	0.010	0.007	0.19	585	75	163	-20
ELM MOBILE	22078	0	0.29	3.42	1.42	0.42	0.10	0.12	0.007	0.009	0.30	701	59	120	-90
KILROOT	18606	0	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007	0.35	630	59	86	-10
GRANGEMOUTH	18607	0	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007	0.35	620	60	82	-70
TRINIDAD1	23091	0	0.26	3.48	1.41	0.46	0.10	0.13	0.011	0.007	0.32	719	72	132	-57
GRANGEMOUTH2	19725	0	0.29	1.95	1.42	0.43	0.10	0.13	0.012	0.008	0.38	669	66	90	-35
MARATHON BRAE	23421	0	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004	0.30	770	73	99	-90

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CONTRACT	FORGE	KEY	C	NI	CR	MO	V	SI	S	P	MN	PRF	RA	IMP	FATT
TUTUKA6	23527	0	0.26	3.51	1.50	0.41	0.11	0.13	0.009	0.005	0.21	740	72	103	-120
KEEPHILLS3	21458	0	0.28	3.40	1.40	0.40	0.11	0.13	0.008	0.005	0.22	772	73	146	-132
BRITOIL	23422	0	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004	0.30	710	74	91	-100
CASTLE PEAK2	21710	0	0.28	3.48	1.43	0.40	0.11	0.14	0.007	0.007	0.23	815	68	141	-100
CASTLE PEAKB2	23428	0	0.25	3.46	1.43	0.44	0.13	0.14	0.009	0.006	0.20	785	72	132	-107
MARATHON BRAE2	23661	0	0.25	3.55	1.48	0.37	0.11	0.14	0.008	0.007	0.22	680	77	102	-113
TORNESS1	22671	0	0.27	3.46	1.43	0.41	0.11	0.15	0.010	0.010	0.18	790	72	102	-102
CASTLE PEAKB	22692	0	0.26	3.49	1.45	0.41	0.12	0.15	0.007	0.008	0.20	780	70	137	-105
RIHAND1	23300	0	0.25	3.41	1.47	0.42	0.11	0.15	0.006	0.005	0.19	735	68	147	-106
DUVHA4	20858	0	0.29	3.50	1.43	0.40	0.12	0.16	0.005	0.006	0.25	787	70	141	-87
WILLINGTON	23121	0	0.27	3.52	1.44	0.41	0.13	0.17	0.005	0.005	0.24	695	72	141	-105
DUVHA3	20712	0	0.30	3.47	1.46	0.40	0.12	0.17	0.009	0.011	0.22	785	66	113	-90
DUVHA2	20349	0	0.26	3.31	1.65	0.43	0.11	0.17	0.008	0.008	0.28	745	71	116	-100
SUNDANCE6	20692	0	0.28	3.46	1.44	0.41	0.13	0.18	0.008	0.007	0.26	710	74	138	-105
DUVHA1	20348	0	0.25	3.48	1.48	0.41	0.13	0.18	0.006	0.005	0.14	725	74	130	-90
EM610STOCK13	21459	0	0.29	1.94	1.29	0.42	0.08	0.18	0.010	0.006	0.40	650	72	95	-90
ADYSS	23224	0	0.28	3.43	1.44	0.36	0.13	0.18	0.005	0.004	0.21	745	70	98	-114
EM610STOCK12	21628	0	0.28	1.91	1.24	0.43	0.08	0.19	0.008	0.008	0.37	695	72	103	-53
CASTLE PEAKB3	23825	0	0.27	3.49	1.50	0.43	0.12	0.19	0.006	0.005	0.25	730	70	121	-89
SUNDANCE5	19290	0	0.30	3.35	1.50	0.40	0.12	0.20	0.006	0.007	0.20	695	74	143	-95
PETERHEAD1	19042	0	0.28	3.47	1.46	0.40	0.14	0.20	0.006	0.008	0.34	770	71	110	-64
EM610STOCK14	21795	0	0.30	1.88	1.23	0.41	0.09	0.22	0.006	0.006	0.23	675	70	128	-66
DRAX.COMPL1	21667	0	0.29	1.92	1.25	0.45	0.11	0.23	0.007	0.008	0.36	710	74	117	-80
BLYTH8	19593	0	0.27	1.85	1.35	0.40	0.09	0.23	0.006	0.008	0.20	660	75	143	-77
QUAD OLYMPUS1	19326	0	0.27	1.80	1.31	0.42	0.10	0.23	0.008	0.009	0.23	570	71	107	-55
MEI BHOPAL	19052	0	0.26	1.80	1.17	0.41	0.00	0.25	0.016	0.018	0.47	650	72	108	999
BANGLADESH	22698	0	0.25	1.89	1.31	0.39	0.09	0.26	0.007	0.008	0.42	656	69	99	999
HIGH SPEED M	23659	0	0.38	3.50	1.80	0.44	0.11	0.27	0.007	0.010	0.28	750	64	84	-71
GRAIN4	19699	0	0.36	3.06	1.23	0.39	0.12	0.28	0.014	0.014	0.38	695	64	118	999
KILROOT1	19190	0	0.24	3.24	1.46	0.38	0.11	0.29	0.010	0.012	0.41	635	75	167	10
AHWAZ2	19376	0	0.37	3.06	1.33	0.38	0.12	0.29	0.011	0.012	0.32	695	67	94	30
TSING YI	18655	0	0.37	2.90	1.32	0.35	0.12	0.29	0.013	0.011	0.41	770	62	0	999
KILROOT3	19377	0	0.30	1.90	1.25	0.38	0.09	0.35	0.008	0.008	0.17	695	71	130	-57

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CONTRACT		KEY	SI	C	S	P	NI	MN	IMP	FATT	PRF	RA
NUCLEAR6	21567	3	0.01	0.24	0.008	0.005	3.43	0.25	210	-100	700	75
PEM1	99999	3	0.01	0.23	0.012	0.009	3.52	0.28	119	999	792	68
KORI2	20865	3	0.02	0.26	0.008	0.007	3.42	0.25	196	-88	755	67
TUTUKA3	22691	2	0.02	0.24	0.006	0.007	3.45	0.34	138	-136	728	73
EM610CSTOCK11	21236	3	0.03	0.32	0.010	0.006	1.93	0.36	94	-55	650	70
CASTLE PEAK4	22291	2	0.03	0.27	0.008	0.006	3.43	0.29	108	-90	777	72
NATIONAL SPARE	20194	2	0.03	0.26	0.008	0.008	3.46	0.40	86	-70	860	66
TUTUKA4	22929	2	0.03	0.24	0.007	0.008	3.45	0.28	147	-121	709	69
HERYL1	21420	2	0.03	0.25	0.009	0.011	1.92	0.35	112	999	598	73
EM610STOCK15B	21796	2	0.04	0.28	0.010	0.005	1.90	0.32	114	-70	675	72
STOCK	22528	2	0.04	0.24	0.008	0.007	3.56	0.36	143	-120	748	72
EM610STOCK9	21999	2	0.04	0.25	0.003	0.010	2.01	0.32	82	999	678	65
HINKLEY POINT	22932	2	0.05	0.27	0.007	0.007	3.60	0.27	123	999	750	67
TUTUKA1	22516	1	0.05	0.27	0.008	0.008	3.68	0.31	103	-85	721	71
ADMIR'Y	23197	1	0.05	0.26	0.005	0.008	3.50	0.32	155	-100	695	75
EM610STOCKC	21008	2	0.06	0.25	0.009	0.008	2.30	0.55	186	-74	670	73
EM610STOCK10	21010	2	0.06	0.26	0.012	0.007	1.94	0.41	120	-79	643	70
ELM150	21016	2	0.06	0.26	0.011	0.010	1.96	0.40	155	-40	656	71
COTTAM3	20091	2	0.06	0.30	0.009	0.007	2.09	0.39	176	-120	665	69
DUVHA6	22065	1	0.06	0.25	0.007	0.007	3.49	0.29	131	-80	700	73
CASTLE PEAK3	21779	1	0.06	0.26	0.009	0.008	3.43	0.27	102	999	828	65
NUCLEAR5	21485	1	0.06	0.25	0.006	0.006	3.49	0.27	235	-95	745	71
DRAX.COMPLB	21668	1	0.06	0.24	0.008	0.005	2.03	0.47	196	-80	665	75
CASTLE PEAK	21351	1	0.06	0.25	0.010	0.005	3.42	0.24	165	999	662	74
TUTUKA5	23500	1	0.06	0.26	0.006	0.006	3.53	0.30	157	-115	723	73
KIPEVU7	18960	2	0.07	0.28	0.012	0.010	2.00	0.43	75	-10	657	70
NIGERIAN NEWS	21039	0	0.08	0.26	0.010	0.005	2.05	0.23	125	-60	593	73
KILROOT4	19724	0	0.08	0.26	0.007	0.017	1.94	0.16	150	-89	585	75
ESCOM SPARE	20855	0	0.08	0.28	0.006	0.009	3.50	0.22	125	-100	732	74
NIGERIA	20914	0	0.08	0.26	0.013	0.005	2.00	0.21	88	-44	623	70
STOCK	22920	1	0.09	0.29	0.012	0.009	1.93	0.44	120	-90	675	73
INCE6	19128	0	0.10	0.28	0.014	0.006	2.05	0.23	167	-20	640	69
RINGHALS	23323	0	0.10	0.28	0.006	0.007	3.49	0.25	147	-100	710	74
GENESSEE2	23058	0	0.10	0.29	0.006	0.005	3.62	0.30	137	-101	780	65
GRAIN1	18038	0	0.10	0.21	0.009	0.008	3.42	0.20	107	-50	850	66
DUVHA5	21033	0	0.10	0.29	0.009	0.007	3.40	0.28	112	-110	748	71
DIDCOT	30439	0	0.11	0.25	0.008	0.006	3.52	0.24	77	999	817	70
TUTUKA2	22527	0	0.11	0.28	0.009	0.006	3.46	0.19	109	-117	745	72
LITTLEBROOK2	19004	0	0.11	0.27	0.011	0.008	2.08	0.22	148	-40	610	72
EM610STOCK8	21922	0	0.11	0.27	0.001	0.007	1.92	0.36	92	999	692	69
MARATHON BRAE3	23682	0	0.11	0.30	0.007	0.005	3.45	0.19	88	-121	750	72
GRANGEMOUTH	18607	0	0.12	0.26	0.011	0.007	1.90	0.35	82	-70	620	60
GRAIN5	18679	0	0.12	0.27	0.008	0.009	3.55	0.33	114	-83	741	69
KILROOT	18606	0	0.12	0.26	0.011	0.007	1.90	0.35	86	-10	630	59
TORNESS2	23075	0	0.12	0.28	0.007	0.007	3.52	0.21	122	-105	770	72
ELM MOBILE	22078	0	0.12	0.29	0.007	0.009	3.42	0.30	120	-90	701	59
ABADAN	19019	0	0.12	0.30	0.010	0.007	2.00	0.19	163	-20	585	75
TUTUKA6	23527	0	0.13	0.26	0.009	0.005	3.51	0.21	103	-120	740	72
TRINIDAD1	23091	0	0.13	0.26	0.011	0.007	3.48	0.32	132	-87	719	72
BRITOIL	23422	0	0.13	0.28	0.009	0.004	3.40	0.30	91	-100	710	74
KEEPHILLS3	21458	0	0.13	0.28	0.008	0.005	3.40	0.22	146	-133	772	73
MARATHON BRAE	23421	0	0.13	0.28	0.009	0.004	3.40	0.30	99	-90	770	73
GRANGEMOUTH2	19725	0	0.13	0.29	0.012	0.008	1.95	0.38	90	-35	669	66

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CONTRACT		KEY	SI	C	S	P	NI	MN	IMP	FATT	PRF	RA
CASTLE PEAKB2	23428	0	0.14	0.25	0.009	0.006	3.46	0.20	132	-107	785	72
MARATHON BRAE2	23661	0	0.14	0.25	0.008	0.007	3.55	0.22	102	-113	680	77
CASTLE PEAK2	21710	0	0.14	0.28	0.007	0.007	3.48	0.23	141	-100	815	68
TORNESS1	22671	0	0.15	0.27	0.010	0.010	3.46	0.18	102	-102	790	72
CASTLE PEAKB	22692	0	0.15	0.26	0.007	0.008	3.49	0.20	137	-105	780	70
RIHAND1	23300	0	0.15	0.25	0.006	0.005	3.41	0.19	147	-106	735	68
DUVHA4	20858	0	0.16	0.29	0.005	0.006	3.50	0.25	141	-87	787	70
DUVHA2	20349	0	0.17	0.26	0.008	0.008	3.31	0.28	116	-100	745	71
WILLINGTON	23121	0	0.17	0.27	0.005	0.005	3.52	0.24	141	-105	695	72
DUVHA3	20712	0	0.17	0.30	0.009	0.011	3.47	0.22	113	-90	785	66
DUVHA1	20348	0	0.18	0.25	0.006	0.005	3.48	0.14	130	-90	725	74
SUNDANCE6	20692	0	0.18	0.28	0.008	0.007	3.46	0.26	138	-105	710	74
EM610STOCK13	21459	0	0.18	0.29	0.010	0.006	1.94	0.40	95	-90	650	72
ADYSS	23224	0	0.18	0.28	0.005	0.004	3.43	0.21	98	-114	745	70
CASTLE PEAKB3	23825	0	0.19	0.27	0.006	0.005	3.49	0.25	121	-89	730	70
EM610STOCK12	21628	0	0.19	0.28	0.008	0.008	1.91	0.37	103	-53	695	72
PETERHEAD1	19042	0	0.20	0.28	0.006	0.008	3.47	0.34	110	-64	770	71
SUNDANCE5	19290	0	0.20	0.30	0.006	0.007	3.35	0.20	143	-95	695	74
EM610STOCK14	21795	0	0.22	0.30	0.006	0.006	1.88	0.23	128	-66	675	70
DRAX.COMPL1	21667	0	0.23	0.29	0.007	0.008	1.92	0.36	117	-80	710	74
BLYTH8	19593	0	0.23	0.27	0.006	0.008	1.85	0.20	143	-77	660	75
QUAD OLYMPUS1	19326	0	0.23	0.27	0.008	0.009	1.80	0.23	107	-55	570	71
EM610BSTOCK8C	21032	2	0.24	0.28	0.009	0.003	1.84	0.18	126	-35	650	72
MEI BHOPAL	19052	0	0.25	0.26	0.016	0.018	1.80	0.47	108	999	650	72
BANGLADESH	22698	0	0.26	0.25	0.007	0.008	1.89	0.42	99	999	656	69
STOCK9	19129	2	0.27	0.36	0.016	0.010	3.11	0.42	147	40	700	66
HIGH SPEED M	23659	0	0.27	0.38	0.007	0.010	3.50	0.28	84	-71	750	64
GRAIN4	19699	0	0.28	0.36	0.014	0.014	3.06	0.38	118	999	695	64
AHWAZ2	19376	0	0.29	0.37	0.011	0.012	3.06	0.32	94	30	695	67
KILROOT1	19190	0	0.29	0.24	0.010	0.012	3.24	0.41	167	10	635	75
TSING YI	18655	0	0.29	0.37	0.013	0.011	2.90	0.41	0	999	770	62
LITTLEBROOK3	20422	2	0.35	0.38	0.015	0.017	2.86	0.38	75	25	650	51
KILROOT3	19377	0	0.35	0.30	0.008	0.008	1.90	0.17	130	-57	695	71

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REPORT INDEXED ON IMPACT

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CONTRACT	FORGE	KEY	IMP	FATT	C	NI	CR	SI	S	P	MN
NUCLEAR5	21485	1	235	-95	0.25	3.49	1.59	0.06	0.006	0.006	0.27
NUCLEAR6	21567	3	210	-100	0.24	3.43	1.62	0.01	0.008	0.005	0.25
KORI2	20865	3	196	-88	0.26	3.42	1.67	0.02	0.008	0.007	0.25
DRAX.COMPLB	21668	1	196	-80	0.24	2.03	1.57	0.06	0.008	0.005	0.47
EM610STOCKC	21008	2	186	-74	0.25	2.30	1.34	0.06	0.009	0.008	0.55
COTTAM3	20091	2	176	-120	0.30	2.09	1.43	0.06	0.009	0.007	0.39
INCE6	19128	0	167	-20	0.28	2.05	1.21	0.10	0.014	0.006	0.23
KILROOT1	19190	0	167	10	0.24	3.24	1.46	0.29	0.010	0.012	0.41
CASTLE PEAK	21351	1	165	999	0.25	3.42	1.59	0.06	0.010	0.005	0.24
ABADAN	19019	0	163	-20	0.30	2.00	1.26	0.12	0.010	0.007	0.19
TUTUKA5	23500	1	157	-115	0.26	3.53	1.49	0.06	0.006	0.006	0.30
ELM150	21016	2	155	-40	0.26	1.96	1.34	0.06	0.011	0.010	0.40
ADMIR'Y	23197	1	155	-100	0.26	3.50	1.47	0.05	0.005	0.008	0.32
KILROOT4	19724	0	150	-89	0.26	1.94	1.24	0.08	0.007	0.017	0.16
LITTLEBROOK2	19004	0	148	-40	0.27	2.08	1.22	0.11	0.011	0.008	0.22
RIHAND1	23300	0	147	-106	0.25	3.41	1.47	0.15	0.006	0.005	0.19
RINGHALS	23323	0	147	-100	0.28	3.49	1.49	0.10	0.006	0.007	0.25
TUTUKA4	22929	2	147	-121	0.24	3.45	1.38	0.03	0.007	0.008	0.28
STOCK9	19129	2	147	40	0.36	3.11	1.26	0.27	0.016	0.010	0.42
KEEPHILLS3	21458	0	146	-132	0.28	3.40	1.40	0.13	0.008	0.005	0.22
SUNDANCE5	19290	0	143	-95	0.30	3.35	1.50	0.20	0.006	0.007	0.20
BLYTH8	19593	0	143	-77	0.27	1.85	1.35	0.23	0.006	0.008	0.20
STOCK	22528	2	143	-120	0.24	3.56	1.40	0.04	0.008	0.007	0.36
DUVHA4	20858	0	141	-87	0.29	3.50	1.43	0.16	0.005	0.006	0.25
WILLINGTON	23121	0	141	-105	0.27	3.52	1.44	0.17	0.005	0.005	0.24
CASTLE PEAK2	21710	0	141	-100	0.28	3.48	1.43	0.14	0.007	0.007	0.23
TUTUKA3	22691	2	138	-136	0.24	3.45	1.47	0.02	0.006	0.007	0.34
SUNDANCE6	20692	0	138	-105	0.28	3.46	1.44	0.18	0.008	0.007	0.26
GENESSEE2	23058	0	137	-101	0.29	3.62	1.66	0.10	0.006	0.005	0.30
CASTLE PEAKB	22692	0	137	-105	0.26	3.49	1.45	0.15	0.007	0.008	0.20
TRINIDAD1	23091	0	132	-57	0.26	3.48	1.41	0.13	0.011	0.007	0.32
CASTLE PEAKB2	23428	0	132	-107	0.25	3.46	1.43	0.14	0.009	0.006	0.20
DUVHA6	22065	1	131	-80	0.25	3.49	1.34	0.06	0.007	0.007	0.29
DUVHA1	20348	0	130	-90	0.25	3.48	1.48	0.18	0.006	0.005	0.14
KILROOT3	19377	0	130	-57	0.30	1.90	1.25	0.35	0.008	0.008	0.17
EM610STOCK14	21795	0	128	-66	0.30	1.88	1.23	0.22	0.006	0.006	0.23
EM610BSTOCK8C	21032	2	126	-35	0.28	1.84	1.24	0.24	0.009	0.003	0.18
NIGERIAN NEWS	21039	0	125	-60	0.26	2.05	1.33	0.08	0.010	0.005	0.23
ESCOM SPARE	20855	0	125	-100	0.28	3.50	1.67	0.08	0.006	0.009	0.22
HINKLEY POINT	22932	2	123	999	0.27	3.60	1.70	0.05	0.007	0.007	0.27
TORNESS2	23075	0	122	-105	0.28	3.52	1.55	0.12	0.007	0.007	0.21
CASTLE PEAKB3	23825	0	121	-89	0.27	3.49	1.50	0.19	0.006	0.005	0.25
STOCK	22920	1	120	-90	0.29	1.93	1.46	0.09	0.012	0.009	0.44
EM610STOCK10	21010	2	120	-79	0.26	1.94	1.42	0.06	0.012	0.007	0.41
ELM MOBILE	22078	0	120	-90	0.29	3.42	1.42	0.12	0.007	0.009	0.30
PEM1	99999	3	119	999	0.23	3.52	1.84	0.01	0.012	0.009	0.28
GRAIN4	19699	0	118	999	0.36	3.06	1.23	0.28	0.014	0.014	0.38
DRAX.COMPL1	21667	0	117	-80	0.29	1.92	1.25	0.23	0.007	0.008	0.36
DUVHA2	20349	0	116	-100	0.26	3.31	1.65	0.17	0.008	0.008	0.28
GRAIN5	18679	0	114	-83	0.27	3.55	1.40	0.12	0.008	0.009	0.33
EM610STOCK15B	21796	2	114	-70	0.28	1.90	1.35	0.04	0.010	0.005	0.32
DUVHA3	20712	0	113	-90	0.30	3.47	1.46	0.17	0.009	0.011	0.22
DUVHA5	21033	0	112	-110	0.29	3.40	1.71	0.10	0.009	0.007	0.28

REPORT INDEXED ON SILICON

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CONTRACT		KEY	SI	C	S	P	NI	MN	IMP	FATT	PRF	RA
NUCLEAR6	21567	3	0.01	0.24	0.008	0.005	3.43	0.25	210	-100	700	75
PEM1	99999	3	0.01	0.23	0.012	0.009	3.52	0.28	119	999	792	68
KORI2	20865	3	0.02	0.26	0.008	0.007	3.42	0.25	196	-88	755	67
TUTUKA3	22691	2	0.02	0.24	0.006	0.007	3.45	0.34	138	-136	728	73
EM610CSTOCK11	21236	3	0.03	0.32	0.010	0.006	1.93	0.36	94	-55	650	70
CASTLE PEAK4	22291	2	0.03	0.27	0.008	0.006	3.43	0.29	108	-90	777	72
NATIONAL SPARE	20194	2	0.03	0.26	0.008	0.008	3.46	0.40	86	-70	860	66
TUTUKA4	22929	2	0.03	0.24	0.007	0.008	3.45	0.28	147	-121	709	69
HERYL1	21420	2	0.03	0.25	0.009	0.011	1.92	0.35	112	999	598	73
EM610STOCK15B	21796	2	0.04	0.28	0.010	0.005	1.90	0.32	114	-70	675	72
STOCK	22528	2	0.04	0.24	0.008	0.007	3.56	0.36	143	-120	748	72
EM610STOCK9	21999	2	0.04	0.25	0.003	0.010	2.01	0.32	82	999	678	65
HINKLEY POINT	22932	2	0.05	0.27	0.007	0.007	3.60	0.27	123	999	750	67
TUTUKA1	22516	1	0.05	0.27	0.008	0.008	3.68	0.31	103	-85	721	71
ADMIR'Y	23197	1	0.05	0.26	0.005	0.008	3.50	0.32	155	-100	695	75
EM610STOCKC	21008	2	0.06	0.25	0.009	0.008	2.30	0.55	186	-74	670	73
EM610STOCK10	21010	2	0.06	0.26	0.012	0.007	1.94	0.41	120	-79	643	70
ELM150	21016	2	0.06	0.26	0.011	0.010	1.96	0.40	155	-40	656	71
COTTAM3	20091	2	0.06	0.30	0.009	0.007	2.09	0.39	176	-120	665	69
DUVHA6	22065	1	0.06	0.25	0.007	0.007	3.49	0.29	131	-80	700	73
CASTLE PEAK3	21779	1	0.06	0.26	0.009	0.008	3.43	0.27	102	999	828	65
NUCLEAR5	21485	1	0.06	0.25	0.006	0.006	3.49	0.27	235	-95	745	71
DRAX.COMPLB	21668	1	0.06	0.24	0.008	0.005	2.03	0.47	196	-80	665	75
CASTLE PEAK	21351	1	0.06	0.25	0.010	0.005	3.42	0.24	165	999	662	74
TUTUKA5	23500	1	0.06	0.26	0.006	0.006	3.53	0.30	157	-115	723	73
KIPEVU7	18960	2	0.07	0.28	0.012	0.010	2.00	0.43	75	-10	657	70
NIGERIAN NEWS	21039	0	0.08	0.26	0.010	0.005	2.05	0.23	125	-60	593	73
KILROOT4	19724	0	0.08	0.26	0.007	0.017	1.94	0.16	150	-89	585	75
ESCOM SPARE	20855	0	0.08	0.28	0.006	0.009	3.50	0.22	125	-100	732	74
NIGERIA	20914	0	0.08	0.26	0.013	0.005	2.00	0.21	88	-44	623	70
STOCK	22920	1	0.09	0.29	0.012	0.009	1.93	0.44	120	-90	675	73
INCE6	19128	0	0.10	0.28	0.014	0.006	2.05	0.23	167	-20	640	69
RINGHALS	23323	0	0.10	0.28	0.006	0.007	3.49	0.25	147	-100	710	74
GENESSEE2	23058	0	0.10	0.29	0.006	0.005	3.62	0.30	137	-101	780	65
GRAIN1	18038	0	0.10	0.21	0.009	0.008	3.42	0.20	107	-50	850	66
DUVHA5	21033	0	0.10	0.29	0.009	0.007	3.40	0.28	112	-110	748	71
DIDCOT	30439	0	0.11	0.25	0.008	0.006	3.52	0.24	77	999	817	70
TUTUKA2	22527	0	0.11	0.28	0.009	0.006	3.46	0.19	109	-117	745	72
LITTLEBROOK2	19004	0	0.11	0.27	0.011	0.008	2.08	0.22	148	-40	610	72
EM610STOCK8	21922	0	0.11	0.27	0.001	0.007	1.92	0.36	92	999	692	69
MARATHON BRAE3	23682	0	0.11	0.30	0.007	0.005	3.45	0.19	88	-121	750	72
GRANGEMOUTH	18607	0	0.12	0.26	0.011	0.007	1.90	0.35	82	-70	620	60
GRAIN5	18679	0	0.12	0.27	0.008	0.009	3.55	0.33	114	-83	741	69
KILROOT	18606	0	0.12	0.26	0.011	0.007	1.90	0.35	86	-10	630	59
TORNESS2	23075	0	0.12	0.28	0.007	0.007	3.52	0.21	122	-105	770	72
ELM MOBILE	22078	0	0.12	0.29	0.007	0.009	3.42	0.30	120	-90	701	59
ABADAN	19019	0	0.12	0.30	0.010	0.007	2.00	0.19	163	-20	585	75
TUTUKA6	23527	0	0.13	0.26	0.009	0.005	3.51	0.21	103	-120	740	72
TRINIDAD1	23091	0	0.13	0.26	0.011	0.007	3.48	0.32	132	-87	719	72
BRITOIL	23422	0	0.13	0.28	0.009	0.004	3.40	0.30	91	-100	710	74
KEEPHILLS3	21458	0	0.13	0.28	0.008	0.005	3.40	0.22	146	-133	772	73
MARATHON BRAE	23421	0	0.13	0.28	0.009	0.004	3.40	0.30	99	-90	770	73
GRANGEMOUTH2	19725	0	0.13	0.29	0.012	0.008	1.95	0.38	90	-35	669	66

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CONTRACT		KEY	SI	C	S	P	NI	MN	IMP	FATT	PRF	RA
CASTLE PEAKB2	23428	0	0.14	0.25	0.009	0.006	3.46	0.20	132	-107	785	72
MARATHON BRAE2	23661	0	0.14	0.25	0.008	0.007	3.55	0.22	102	-113	680	77
CASTLE PEAK2	21710	0	0.14	0.28	0.007	0.007	3.48	0.23	141	-100	815	68
TORNESS1	22671	0	0.15	0.27	0.010	0.010	3.46	0.18	102	-102	790	72
CASTLE PEAKB	22692	0	0.15	0.26	0.007	0.008	3.49	0.20	137	-105	780	70
RIHAND1	23300	0	0.15	0.25	0.006	0.005	3.41	0.19	147	-106	735	68
DUVHA4	20858	0	0.16	0.29	0.005	0.006	3.50	0.25	141	-87	787	70
DUVHA2	20349	0	0.17	0.26	0.008	0.008	3.31	0.28	116	-100	745	71
WILLINGTON	23121	0	0.17	0.27	0.005	0.005	3.52	0.24	141	-105	695	72
DUVHA3	20712	0	0.17	0.30	0.009	0.011	3.47	0.22	113	-90	785	66
DUVHA1	20348	0	0.18	0.25	0.006	0.005	3.48	0.14	130	-90	725	74
SUNDANCE6	20692	0	0.18	0.28	0.008	0.007	3.46	0.26	138	-105	710	74
EM610STOCK13	21459	0	0.18	0.29	0.010	0.006	1.94	0.40	95	-90	650	72
ADYSS	23224	0	0.18	0.28	0.005	0.004	3.43	0.21	98	-114	745	70
CASTLE PEAKB3	23825	0	0.19	0.27	0.006	0.005	3.49	0.25	121	-89	730	70
EM610STOCK12	21628	0	0.19	0.28	0.008	0.008	1.91	0.37	103	-53	695	72
PETERHEAD1	19042	0	0.20	0.28	0.006	0.008	3.47	0.34	110	-64	770	71
SUNDANCE5	19290	0	0.20	0.30	0.006	0.007	3.35	0.20	143	-95	695	74
EM610STOCK14	21795	0	0.22	0.30	0.006	0.006	1.88	0.23	128	-66	675	70
DRAX.COMPL1	21667	0	0.23	0.29	0.007	0.008	1.92	0.36	117	-80	710	74
BLYTH8	19593	0	0.23	0.27	0.006	0.008	1.85	0.20	143	-77	660	75
QUAD OLYMPUS1	19326	0	0.23	0.27	0.008	0.009	1.80	0.23	107	-55	570	71
EM610BSTOCK8C	21032	2	0.24	0.28	0.009	0.003	1.84	0.18	126	-35	650	72
MEI BHOPAL	19052	0	0.25	0.26	0.016	0.018	1.80	0.47	108	999	650	72
BANGLADESH	22698	0	0.26	0.25	0.007	0.008	1.89	0.42	99	999	656	69
STOCK9	19129	2	0.27	0.36	0.016	0.010	3.11	0.42	147	40	700	66
HIGH SPEED M	23659	0	0.27	0.38	0.007	0.010	3.50	0.28	84	-71	750	64
GRAIN4	19699	0	0.28	0.36	0.014	0.014	3.06	0.38	118	999	695	64
AHWAZ2	19376	0	0.29	0.37	0.011	0.012	3.06	0.32	94	30	695	67
KILROOT1	19190	0	0.29	0.24	0.010	0.012	3.24	0.41	167	10	635	75
TSING YI	18655	0	0.29	0.37	0.013	0.011	2.90	0.41	0	999	770	62
LITTLEBROOK3	20422	2	0.35	0.38	0.015	0.017	2.86	0.38	75	25	650	51
KILROOT3	19377	0	0.35	0.30	0.008	0.008	1.90	0.17	130	-57	695	71

End of Report

REPORT INDEXED ON IMPACT

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CONTRACT	FORGE	KEY	IMP	FATT	C	NI	CR	SI	S	P	MN
NUCLEAR5	21485	1	235	-95	0.25	3.49	1.59	0.06	0.006	0.006	0.27
NUCLEAR6	21567	3	210	-100	0.24	3.43	1.62	0.01	0.008	0.005	0.25
KORI2	20865	3	196	-88	0.26	3.42	1.67	0.02	0.008	0.007	0.25
DRAX.COMPLB	21668	1	196	-80	0.24	2.03	1.57	0.06	0.008	0.005	0.47
EM610STOCKC	21008	2	186	-74	0.25	2.30	1.34	0.06	0.009	0.008	0.55
COTTAM3	20091	2	176	-120	0.30	2.09	1.43	0.06	0.009	0.007	0.39
INCE6	19128	0	167	-20	0.28	2.05	1.21	0.10	0.014	0.006	0.23
KILROOT1	19190	0	167	10	0.24	3.24	1.46	0.29	0.010	0.012	0.41
CASTLE PEAK	21351	1	165	999	0.25	3.42	1.59	0.06	0.010	0.005	0.24
ABADAN	19019	0	163	-20	0.30	2.00	1.26	0.12	0.010	0.007	0.19
TUTUKA5	23500	1	157	-115	0.26	3.53	1.49	0.06	0.006	0.006	0.30
ELM150	21016	2	155	-40	0.26	1.96	1.34	0.06	0.011	0.010	0.40
ADMIR'Y	23197	1	155	-100	0.26	3.50	1.47	0.05	0.005	0.008	0.32
KILROOT4	19724	0	150	-89	0.26	1.94	1.24	0.08	0.007	0.017	0.16
LITTLEBROOK2	19004	0	148	-40	0.27	2.08	1.22	0.11	0.011	0.008	0.22
RIHAND1	23300	0	147	-106	0.25	3.41	1.47	0.15	0.006	0.005	0.19
RINGHALS	23323	0	147	-100	0.28	3.49	1.49	0.10	0.006	0.007	0.25
TUTUKA4	22929	2	147	-121	0.24	3.45	1.38	0.03	0.007	0.008	0.28
STOCK9	19129	2	147	40	0.36	3.11	1.26	0.27	0.016	0.010	0.42
KEEPHILLS3	21458	0	146	-132	0.28	3.40	1.40	0.13	0.008	0.005	0.22
SUNDANCE5	19290	0	143	-95	0.30	3.35	1.50	0.20	0.006	0.007	0.20
BLYTH8	19593	0	143	-77	0.27	1.85	1.35	0.23	0.006	0.008	0.20
STOCK	22528	2	143	-120	0.24	3.56	1.40	0.04	0.008	0.007	0.36
DUVHA4	20858	0	141	-87	0.29	3.50	1.43	0.16	0.005	0.006	0.25
WILLINGTON	23121	0	141	-105	0.27	3.52	1.44	0.17	0.005	0.005	0.24
CASTLE PEAK2	21710	0	141	-100	0.28	3.48	1.43	0.14	0.007	0.007	0.23
TUTUKA3	22691	2	138	-136	0.24	3.45	1.47	0.02	0.006	0.007	0.34
SUNDANCE6	20692	0	138	-105	0.28	3.46	1.44	0.18	0.008	0.007	0.26
GENESSEE2	23058	0	137	-101	0.29	3.62	1.66	0.10	0.006	0.005	0.30
CASTLE PEAKB	22692	0	137	-105	0.26	3.49	1.45	0.15	0.007	0.008	0.20
TRINIDAD1	23091	0	132	-57	0.26	3.48	1.41	0.13	0.011	0.007	0.32
CASTLE PEAKB2	23428	0	132	-107	0.25	3.46	1.43	0.14	0.009	0.006	0.20
DUVHA6	22065	1	131	-80	0.25	3.49	1.34	0.06	0.007	0.007	0.29
DUVHA1	20348	0	130	-90	0.25	3.48	1.48	0.18	0.006	0.005	0.14
KILROOT3	19377	0	130	-57	0.30	1.90	1.25	0.35	0.008	0.008	0.17
EM610STOCK14	21795	0	128	-66	0.30	1.88	1.23	0.22	0.006	0.006	0.23
EM610BSTOCK8C	21032	2	126	-35	0.28	1.84	1.24	0.24	0.009	0.003	0.18
NIGERIAN NEWS	21039	0	125	-60	0.26	2.05	1.33	0.08	0.010	0.005	0.23
ESCOM SPARE	20855	0	125	-100	0.28	3.50	1.67	0.08	0.006	0.009	0.22
HINKLEY POINT	22932	2	123	999	0.27	3.60	1.70	0.05	0.007	0.007	0.27
TORNESS2	23075	0	122	-105	0.28	3.52	1.55	0.12	0.007	0.007	0.21
CASTLE PEAKB3	23825	0	121	-89	0.27	3.49	1.50	0.19	0.006	0.005	0.25
STOCK	22920	1	120	-90	0.29	1.93	1.46	0.09	0.012	0.009	0.44
EM610STOCK10	21010	2	120	-79	0.26	1.94	1.42	0.06	0.012	0.007	0.41
ELM MOBILE	22078	0	120	-90	0.29	3.42	1.42	0.12	0.007	0.009	0.30
PEM1	99999	3	119	999	0.23	3.52	1.84	0.01	0.012	0.009	0.28
GRAIN4	19699	0	118	999	0.36	3.06	1.23	0.28	0.014	0.014	0.38
DRAX.COMPL1	21667	0	117	-80	0.29	1.92	1.25	0.23	0.007	0.008	0.36
DUVHA2	20349	0	116	-100	0.26	3.31	1.65	0.17	0.008	0.008	0.28
GRAIN5	18679	0	114	-83	0.27	3.55	1.40	0.12	0.008	0.009	0.33
EM610STOCK15B	21796	2	114	-70	0.28	1.90	1.35	0.04	0.010	0.005	0.32
DUVHA3	20712	0	113	-90	0.30	3.47	1.46	0.17	0.009	0.011	0.22
DUVHA5	21033	0	112	-110	0.29	3.40	1.71	0.10	0.009	0.007	0.28

Indexed on Impact

CONTRACT	FORGE	KEY	IMP	FATT	C	NI	CR	SI	S	P	MN
BERYL1	21420	2	112	999	0.25	1.92	1.41	0.03	0.009	0.011	0.35
PETERHEAD1	19042	0	110	-64	0.28	3.47	1.46	0.20	0.006	0.008	0.34
TUTUKA2	22527	0	109	-117	0.28	3.46	1.45	0.11	0.009	0.006	0.19
CASTLE PEAK4	22291	2	108	-90	0.27	3.43	1.42	0.03	0.008	0.006	0.29
MEI BHOPAL	19052	0	108	999	0.26	1.80	1.17	0.25	0.016	0.018	0.47
QUAD OLYMPUS1	19326	0	107	-55	0.27	1.80	1.31	0.23	0.008	0.009	0.23
GRAIN1	18038	0	107	-50	0.21	3.42	1.47	0.10	0.009	0.008	0.20
EM610STOCK12	21628	0	103	-53	0.28	1.91	1.24	0.19	0.008	0.008	0.37
TUTUKA1	22516	1	103	-85	0.27	3.68	1.74	0.05	0.008	0.008	0.31
TUTUKA6	23527	0	103	-120	0.26	3.51	1.50	0.13	0.009	0.005	0.21
CASTLE PEAK3	21779	1	102	999	0.26	3.43	1.40	0.06	0.009	0.008	0.27
TORNESS1	22671	0	102	-102	0.27	3.46	1.43	0.15	0.010	0.010	0.18
MARATHON BRAE2	23661	0	102	-113	0.25	3.55	1.48	0.14	0.008	0.007	0.22
BANGLADESH	22698	0	99	999	0.25	1.89	1.31	0.26	0.007	0.008	0.42
MARATHON BRAE	23421	0	99	-90	0.28	3.40	1.48	0.13	0.009	0.004	0.30
ADYSS	23224	0	98	-114	0.28	3.43	1.44	0.18	0.005	0.004	0.21
EM610STOCK13	21459	0	95	-90	0.29	1.94	1.29	0.18	0.010	0.006	0.40
AHWA22	19376	0	94	30	0.37	3.06	1.33	0.29	0.011	0.012	0.32
EM610CSTOCK11	21236	3	94	-55	0.32	1.93	1.37	0.03	0.010	0.006	0.36
EM610STOCK8	21922	0	92	999	0.27	1.92	1.27	0.11	0.001	0.007	0.36
BRITOIL	23422	0	91	-100	0.28	3.40	1.48	0.13	0.009	0.004	0.30
GRANGEMOUTH2	19725	0	90	-35	0.29	1.95	1.42	0.13	0.012	0.008	0.38
MARATHON BRAE3	23682	0	88	-121	0.30	3.45	1.42	0.11	0.007	0.005	0.19
NIGERIA	20914	0	88	-44	0.26	2.00	1.31	0.08	0.013	0.005	0.21
KILROOT	18606	0	86	-10	0.26	1.90	1.23	0.12	0.011	0.007	0.35
NATIONAL SPARE	20194	2	86	-70	0.26	3.46	1.40	0.03	0.008	0.008	0.40
HIGH SPEED M	23659	0	84	-71	0.38	3.50	1.80	0.27	0.007	0.010	0.28
EM610STOCK9	21999	2	82	999	0.25	2.01	1.32	0.04	0.003	0.010	0.32
GRANGEMOUTH	18607	0	82	-70	0.26	1.90	1.23	0.12	0.011	0.007	0.35
DIDCOT	30439	0	77	999	0.25	3.52	1.56	0.11	0.008	0.006	0.24
RIPEVU7	18960	2	75	-10	0.28	2.00	1.34	0.07	0.012	0.010	0.43
LITTLEBROOK3	20422	2	75	25	0.38	2.86	1.33	0.35	0.015	0.017	0.38
TSING YI	18655	0	0	999	0.37	2.90	1.32	0.29	0.013	0.011	0.41

End of Report

REPORT INDEXED ON SULPHUR

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CONTRACT	FORGE	KEY	S	P	SI	C	MN	CR	V	IMP	FATT	PRF
EM610STOCK8	21922	0	0.001	0.007	0.11	0.27	0.36	1.27	0.10	92	999	692
EM610STOCK9	21999	2	0.003	0.010	0.04	0.25	0.32	1.32	0.10	82	999	678
ADMIR'Y	23197	1	0.005	0.008	0.05	0.26	0.32	1.47	0.13	155	-100	695
WILLINGTON	23121	0	0.005	0.005	0.17	0.27	0.24	1.44	0.13	141	-105	695
DUVHA4	20858	0	0.005	0.006	0.16	0.29	0.25	1.43	0.12	141	-87	787
ADYSS	23224	0	0.005	0.004	0.18	0.28	0.21	1.44	0.13	98	-114	745
TUTUKA3	22691	2	0.006	0.007	0.02	0.24	0.34	1.47	0.10	138	-136	728
NUCLEAR5	21485	1	0.006	0.006	0.06	0.25	0.27	1.59	0.13	235	-95	745
TUTUKA5	23500	1	0.006	0.006	0.06	0.26	0.30	1.49	0.10	157	-115	723
GENESSEE2	23058	0	0.006	0.005	0.10	0.29	0.30	1.66	0.12	137	-101	780
PETERHEAD1	19042	0	0.006	0.008	0.20	0.28	0.34	1.46	0.14	110	-64	770
DUVHA1	20348	0	0.006	0.005	0.18	0.25	0.14	1.48	0.13	130	-90	725
EM610STOCK14	21795	0	0.006	0.006	0.22	0.30	0.23	1.23	0.09	128	-66	675
RIHAND1	23300	0	0.006	0.005	0.15	0.25	0.19	1.47	0.11	147	-106	735
CASTLE PEAKB3	23825	0	0.006	0.005	0.19	0.27	0.25	1.50	0.12	121	-89	730
SUNDANCE5	19290	0	0.006	0.007	0.20	0.30	0.20	1.50	0.12	143	-95	695
BLYTH8	19593	0	0.006	0.008	0.23	0.27	0.20	1.35	0.09	143	-77	660
RINGHALS	23323	0	0.006	0.007	0.10	0.28	0.25	1.49	0.14	147	-100	710
ESCOM SPARE	20855	0	0.006	0.009	0.08	0.28	0.22	1.67	0.11	125	-100	732
HINKLEY POINT	22932	2	0.007	0.007	0.05	0.27	0.27	1.70	0.12	123	999	750
TUTUKA4	22929	2	0.007	0.008	0.03	0.24	0.28	1.38	0.09	147	-121	709
DUVHA6	22065	1	0.007	0.007	0.06	0.25	0.29	1.34	0.11	131	-80	700
CASTLE PEAK2	21710	0	0.007	0.007	0.14	0.28	0.23	1.43	0.11	141	-100	815
MARATHON BRAE3	23682	0	0.007	0.005	0.11	0.30	0.19	1.42	0.10	88	-121	750
KILROOT4	19724	0	0.007	0.017	0.08	0.26	0.16	1.24	0.11	150	-89	585
BANGLADESH	22698	0	0.007	0.008	0.26	0.25	0.42	1.31	0.09	99	999	656
DRAX.COMPL1	21667	0	0.007	0.008	0.23	0.29	0.36	1.25	0.11	117	-80	710
CASTLE PEAKB	22692	0	0.007	0.008	0.15	0.26	0.20	1.45	0.12	137	-105	780
HIGH SPEED M	23659	0	0.007	0.010	0.27	0.38	0.28	1.80	0.11	84	-71	750
TORNESS2	23075	0	0.007	0.007	0.12	0.28	0.21	1.55	0.12	122	-105	770
ELM MOBILE	22078	0	0.007	0.009	0.12	0.29	0.30	1.42	0.10	120	-90	701
NUCLEAR6	21567	3	0.008	0.005	0.01	0.24	0.25	1.62	0.12	210	-100	700
KOR12	20865	3	0.008	0.007	0.02	0.26	0.25	1.67	0.10	196	-88	755
NATIONAL SPARE	20194	2	0.008	0.008	0.03	0.26	0.40	1.40	0.08	86	-70	860
STOCK	22528	2	0.008	0.007	0.04	0.24	0.36	1.40	0.10	143	-120	748
CASTLE PEAK4	22291	2	0.008	0.006	0.03	0.27	0.29	1.42	0.09	108	-90	777
DRAX.COMPLB	21668	1	0.008	0.005	0.06	0.24	0.47	1.57	0.10	196	-80	665
TUTUKA1	22516	1	0.008	0.008	0.05	0.27	0.31	1.74	0.11	103	-85	721
GRAIN5	18679	0	0.008	0.009	0.12	0.27	0.33	1.40	0.14	114	-83	741
DIDCOT	30439	0	0.008	0.006	0.11	0.25	0.24	1.56	0.12	77	999	817
MARATHON BRAE2	23661	0	0.008	0.007	0.14	0.25	0.22	1.48	0.11	102	-113	680
KEEPHILLS3	21458	0	0.008	0.005	0.13	0.28	0.22	1.40	0.11	146	-132	772
KILROOT3	19377	0	0.008	0.008	0.35	0.30	0.17	1.25	0.09	130	-57	695
QUAD OLYMPUS1	19326	0	0.008	0.009	0.23	0.27	0.23	1.31	0.10	107	-55	670
DUVHA2	20349	0	0.008	0.008	0.17	0.26	0.28	1.65	0.11	116	-100	745
EM610STOCK12	21628	0	0.008	0.008	0.19	0.28	0.37	1.24	0.08	103	-53	695
SUNDANCE6	20692	0	0.008	0.007	0.18	0.28	0.26	1.44	0.13	138	-105	710
BERYL1	21420	2	0.009	0.011	0.03	0.25	0.35	1.41	0.09	112	999	598
EM610STOCKC	21008	2	0.009	0.008	0.06	0.25	0.55	1.34	0.10	186	-74	670
COTTAM3	20091	2	0.009	0.007	0.06	0.30	0.39	1.43	0.09	176	-120	665
EM610BSTOCK8C	21032	2	0.009	0.003	0.24	0.28	0.18	1.24	0.09	126	-35	650
CASTLE PEAK3	21779	1	0.009	0.008	0.06	0.26	0.27	1.40	0.10	102	999	828
TUTUKA2	22527	0	0.009	0.006	0.11	0.28	0.19	1.45	0.11	109	-117	745

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CONTRACT	FORGE	KEY	S	P	SI	C	MN	CR	V	IMP	FATT	PRF
DUVHA3	20712	0	0.009	0.011	0.17	0.30	0.22	1.46	0.12	113	-90	785
GRAIN1	18038	0	0.009	0.008	0.10	0.21	0.20	1.47	0.10	107	-50	850
CASTLE PEAKB2	23428	0	0.009	0.006	0.14	0.25	0.20	1.43	0.13	132	-107	785
BRITOIL	23422	0	0.009	0.004	0.13	0.28	0.30	1.48	0.11	91	-100	710
DUVHA5	21033	0	0.009	0.007	0.10	0.29	0.28	1.71	0.11	112	-110	748
TUTUKA6	23527	0	0.009	0.005	0.13	0.26	0.21	1.50	0.11	103	-120	740
MARATHON BRAE	23421	0	0.009	0.004	0.13	0.28	0.30	1.48	0.11	99	-90	770
EM610CSTOCK11	21236	3	0.010	0.006	0.03	0.32	0.36	1.37	0.09	94	-55	650
EM610STOCK15B	21796	2	0.010	0.005	0.04	0.28	0.32	1.35	0.10	114	-70	675
CASTLE PEAK	21351	1	0.010	0.005	0.06	0.25	0.24	1.59	0.10	165	999	662
KILROOT1	19190	0	0.010	0.012	0.29	0.24	0.41	1.46	0.11	167	10	635
NIGERIAN NEWS	21039	0	0.010	0.005	0.08	0.26	0.23	1.33	0.09	125	-60	593
ABADAN	19019	0	0.010	0.007	0.12	0.30	0.19	1.26	0.11	163	-20	585
TORNESS1	22671	0	0.010	0.010	0.15	0.27	0.18	1.43	0.11	102	-102	790
EM610STOCK13	21459	0	0.010	0.006	0.18	0.29	0.40	1.29	0.08	95	-90	650
ELM150	21016	2	0.011	0.010	0.06	0.26	0.40	1.34	0.12	155	-40	656
TRINIDAD1	23091	0	0.011	0.007	0.13	0.26	0.32	1.41	0.10	132	-57	719
AHWA22	19376	0	0.011	0.012	0.29	0.37	0.32	1.33	0.12	94	30	695
LITTLEBROOK2	19004	0	0.011	0.008	0.11	0.27	0.22	1.22	0.15	148	-40	610
KILROOT	18606	0	0.011	0.007	0.12	0.26	0.35	1.23	0.11	86	-10	630
GRANGEMOUTH	18607	0	0.011	0.007	0.12	0.26	0.35	1.23	0.11	82	-70	620
PEM1	99999	3	0.012	0.009	0.01	0.23	0.28	1.84	0.10	119	999	792
KIPEVU7	18960	2	0.012	0.010	0.07	0.28	0.43	1.34	0.10	75	-10	657
EM610STOCK10	21010	2	0.012	0.007	0.06	0.26	0.41	1.42	0.09	120	-79	643
STOCK	22920	1	0.012	0.009	0.09	0.29	0.44	1.46	0.11	120	-90	675
GRANGEMOUTH2	19725	0	0.012	0.008	0.13	0.29	0.38	1.42	0.10	90	-35	669
TSING YI	18655	0	0.013	0.011	0.29	0.37	0.41	1.32	0.12	0	999	770
NIGERIA	20914	0	0.013	0.005	0.08	0.26	0.21	1.31	0.10	88	-44	623
GRAIN4	19699	0	0.014	0.014	0.28	0.36	0.38	1.23	0.12	118	999	695
INCE6	19128	0	0.014	0.006	0.10	0.28	0.23	1.21	0.13	167	-20	640
LITTLEBROOK3	20422	2	0.015	0.017	0.35	0.38	0.38	1.33	0.13	75	25	650
STOCK9	19129	2	0.016	0.010	0.27	0.36	0.42	1.26	0.13	147	40	700
MEI BHOPAL	19052	0	0.016	0.018	0.25	0.26	0.47	1.17	0.00	108	999	650

End of Report

REPORT INDEXED ON MANGANESE

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CONTRACT	FORGE	KEY	MN	SI	NI	CR	S	P	C	IMP	FATT	PRF	RA
EM610STOCKC	21008	2	0.55	0.06	2.30	1.34	0.009	0.008	0.25	186	-74	670	73
MEI BHOPAL	19052	0	0.47	0.25	1.80	1.17	0.016	0.018	0.26	108	999	650	72
DRAX.COMPLB	21668	1	0.47	0.06	2.03	1.57	0.008	0.005	0.24	196	-80	665	75
STOCK	22920	1	0.44	0.09	1.93	1.46	0.012	0.009	0.29	120	-90	675	73
KIPEVU7	18960	2	0.43	0.07	2.00	1.34	0.012	0.010	0.28	75	-10	657	70
STOCK9	19129	2	0.42	0.27	3.11	1.26	0.016	0.010	0.36	147	40	700	66
BANGLADESH	22698	0	0.42	0.26	1.89	1.31	0.007	0.008	0.25	99	999	656	69
TSING YI	18655	0	0.41	0.29	2.90	1.32	0.013	0.011	0.37	0	999	770	62
KILROOT1	19190	0	0.41	0.29	3.24	1.46	0.010	0.012	0.24	167	10	635	75
EM610STOCK10	21010	2	0.41	0.06	1.94	1.42	0.012	0.007	0.26	120	-79	643	70
EM610STOCK13	21459	0	0.40	0.18	1.94	1.29	0.010	0.006	0.29	95	-90	650	72
ELM150	21016	2	0.40	0.06	1.96	1.34	0.011	0.010	0.26	155	-40	656	71
NATIONAL SPARE	20194	2	0.40	0.03	3.46	1.40	0.008	0.008	0.26	86	-70	860	66
COTTAM3	20091	2	0.39	0.06	2.09	1.43	0.009	0.007	0.30	176	-120	665	69
LITTLEBROOK3	20422	2	0.38	0.35	2.86	1.33	0.015	0.017	0.38	75	25	650	51
GRAIN4	19699	0	0.38	0.28	3.06	1.23	0.014	0.014	0.36	118	999	695	64
GRANGEMOUTH2	19725	0	0.38	0.13	1.95	1.42	0.012	0.008	0.29	90	-35	669	66
EM610STOCK12	21628	0	0.37	0.19	1.91	1.24	0.008	0.008	0.28	103	-53	695	72
DRAX.COMPL1	21667	0	0.36	0.23	1.92	1.25	0.007	0.008	0.29	117	-80	710	74
EM610STOCK8	21922	0	0.36	0.11	1.92	1.27	0.001	0.007	0.27	92	999	692	69
STOCK	22528	2	0.36	0.04	3.56	1.40	0.008	0.007	0.24	143	-120	748	72
EM610CSTOCK11	21236	3	0.36	0.03	1.93	1.37	0.010	0.006	0.32	94	-55	650	70
GRANGEMOUTH	18607	0	0.35	0.12	1.90	1.23	0.011	0.007	0.26	82	-70	620	60
KILROOT	18606	0	0.35	0.12	1.90	1.23	0.011	0.007	0.26	86	-10	630	59
BERYL1	21420	2	0.35	0.03	1.92	1.41	0.009	0.011	0.25	112	999	598	73
PETERHEAD1	19042	0	0.34	0.20	3.47	1.46	0.006	0.008	0.28	110	-64	770	71
TUTUKA3	22691	2	0.34	0.02	3.45	1.47	0.006	0.007	0.24	138	-136	728	73
GRAIN5	18679	0	0.33	0.12	3.55	1.40	0.008	0.009	0.27	114	-83	741	69
AHWAZ2	19376	0	0.32	0.29	3.06	1.33	0.011	0.012	0.37	94	30	695	67
TRINIDAD1	23091	0	0.32	0.13	3.48	1.41	0.011	0.007	0.26	132	-57	719	72
ADMIR'Y	23197	1	0.32	0.05	3.50	1.47	0.005	0.008	0.26	155	-100	695	75
EM610STOCK15B	21796	2	0.32	0.04	1.90	1.35	0.010	0.005	0.28	114	-70	675	72
EM610STOCK9	21999	2	0.32	0.04	2.01	1.32	0.003	0.010	0.25	82	999	678	65
TUTUKA1	22516	1	0.31	0.05	3.68	1.74	0.008	0.008	0.27	103	-85	721	71
MARATHON BRAE	23421	0	0.30	0.13	3.40	1.48	0.009	0.004	0.28	99	-90	770	73
BRITOIL	23422	0	0.30	0.13	3.40	1.48	0.009	0.004	0.28	91	-100	710	74
ELM MOBILE	22078	0	0.30	0.12	3.42	1.42	0.007	0.009	0.29	120	-90	701	59
GENESSEE2	23058	0	0.30	0.10	3.62	1.66	0.006	0.005	0.29	137	-101	780	65
TUTUKA5	23500	1	0.30	0.06	3.53	1.49	0.006	0.006	0.26	157	-115	723	73
DUVHA6	22065	1	0.29	0.06	3.49	1.34	0.007	0.007	0.25	131	-80	700	73
CASTLE PEAK4	22291	2	0.29	0.03	3.43	1.42	0.008	0.006	0.27	108	-90	777	72
HIGH SPEED M	23659	0	0.28	0.27	3.50	1.80	0.007	0.010	0.38	84	-71	750	64
DUVHA2	20349	0	0.28	0.17	3.31	1.65	0.008	0.008	0.26	116	-100	745	71
DUVHA5	21033	0	0.28	0.10	3.40	1.71	0.009	0.007	0.29	112	-110	748	71
TUTUKA4	22929	2	0.28	0.03	3.45	1.38	0.007	0.008	0.24	147	-121	709	69
PEM1	99999	3	0.28	0.01	3.52	1.84	0.012	0.009	0.23	119	999	792	68
CASTLE PEAK3	21779	1	0.27	0.06	3.43	1.40	0.009	0.008	0.26	102	999	828	65
NUCLEAR5	21485	1	0.27	0.06	3.49	1.59	0.006	0.006	0.25	235	-95	745	71
HINKLEY POINT	22932	2	0.27	0.05	3.60	1.70	0.007	0.007	0.27	123	999	750	67
SUNDANCE6	20692	0	0.26	0.18	3.46	1.44	0.008	0.007	0.28	138	-105	710	74
CASTLE PEAKB3	23825	0	0.25	0.19	3.49	1.50	0.006	0.005	0.27	121	-89	730	70
DUVHA4	20858	0	0.25	0.16	3.50	1.43	0.005	0.006	0.29	141	-87	787	70
RINGHALS	23323	0	0.25	0.10	3.49	1.49	0.006	0.007	0.28	147	-100	710	74

Indexed on Manganese Sheet 2 of 2

CONTRACT	FORGE	KEY	MN	SI	NI	CR	S	P	C	IMP	FATT	PRF	RA
KORI2	20865	3	0.25	0.02	3.42	1.67	0.008	0.007	0.26	196	-88	755	67
NUCLEAR6	21567	3	0.25	0.01	3.43	1.62	0.008	0.005	0.24	210	-100	700	75
WILLINGTON	23121	0	0.24	0.17	3.52	1.44	0.005	0.005	0.27	141	-105	695	72
DIDCOT	30439	0	0.24	0.11	3.52	1.56	0.008	0.006	0.25	77	999	817	70
CASTLE PEAK	21351	1	0.24	0.06	3.42	1.59	0.010	0.005	0.25	165	999	662	74
QUAD OLYMPUS1	19326	0	0.23	0.23	1.80	1.31	0.008	0.009	0.27	107	-55	570	71
EM610STOCK14	21795	0	0.23	0.22	1.88	1.23	0.006	0.006	0.30	128	-66	675	70
CASTLE PEAK2	21710	0	0.23	0.14	3.48	1.43	0.007	0.007	0.28	141	-100	815	68
INCE6	19128	0	0.23	0.10	2.05	1.21	0.014	0.006	0.28	167	-20	640	69
NIGERIAN NEWS	21039	0	0.23	0.08	2.05	1.33	0.010	0.005	0.26	125	-60	593	73
DUVHA3	20712	0	0.22	0.17	3.47	1.46	0.009	0.011	0.30	113	-90	785	66
MARATHON BRAE2	23661	0	0.22	0.14	3.55	1.48	0.008	0.007	0.25	102	-113	680	77
KEEPHILLS3	21458	0	0.22	0.13	3.40	1.40	0.008	0.005	0.28	146	-132	772	73
LITTLEBROOK2	19004	0	0.22	0.11	2.08	1.22	0.011	0.008	0.27	148	-40	610	72
ESCOM SPARE	20855	0	0.22	0.08	3.50	1.67	0.006	0.009	0.28	125	-100	732	74
ADYSS	23224	0	0.21	0.18	3.43	1.44	0.005	0.004	0.28	98	-114	745	70
TUTUKA6	23527	0	0.21	0.13	3.51	1.50	0.009	0.005	0.26	103	-120	740	72
TORNESS2	23075	0	0.21	0.12	3.52	1.55	0.007	0.007	0.28	122	-105	770	72
NIGERIA	20914	0	0.21	0.08	2.00	1.31	0.013	0.005	0.26	88	-44	623	70
BLYTH8	19593	0	0.20	0.23	1.85	1.35	0.006	0.008	0.27	143	-77	660	75
SUNDANCE5	19290	0	0.20	0.20	3.36	1.50	0.006	0.007	0.30	143	-95	695	74
CASTLE PEAKB	22692	0	0.20	0.15	3.49	1.45	0.007	0.008	0.26	137	-105	780	70
CASTLE PEAKB2	23428	0	0.20	0.14	3.46	1.43	0.009	0.006	0.25	132	-107	785	72
GRAIN1	18038	0	0.20	0.10	3.42	1.47	0.009	0.008	0.21	107	-50	850	66
RIHAND1	23300	0	0.19	0.15	3.41	1.47	0.006	0.005	0.25	147	-106	735	68
ABADAN	19019	0	0.19	0.12	2.00	1.26	0.010	0.007	0.30	163	-20	585	75
MARATHON BRAE3	23682	0	0.19	0.11	3.45	1.42	0.007	0.005	0.30	88	-121	750	72
TUTUKA2	22527	0	0.19	0.11	3.46	1.45	0.009	0.006	0.28	109	-117	745	72
EM610BSTOCK8C	21032	2	0.18	0.24	1.84	1.24	0.009	0.003	0.28	126	-35	650	72
TORNESS1	22671	0	0.18	0.15	3.46	1.43	0.010	0.010	0.27	102	-102	790	72
KILROOT3	19377	0	0.17	0.35	1.90	1.25	0.008	0.008	0.30	130	-57	695	71
KILROOT4	19724	0	0.16	0.08	1.94	1.24	0.007	0.017	0.26	150	-89	585	75
DUVHA1	20348	0	0.14	0.18	3.48	1.48	0.006	0.005	0.25	130	-90	725	74

End of Report

REPORT INDEXED ON PROOF STRESS

Indexed on Proof Stress Sheet 1 of 2

CONTRACT	FORGE	KEY	PROOF	UTS	IMP	RA	C	NI	CR	MO	V	SI	S	P
NATIONAL SPARE	20194	2	860	990	86	66	0.26	3.46	1.40	0.45	0.08	0.03	0.008	0.008
GRAIN1	18038	0	850	960	107	66	0.21	3.42	1.47	0.50	0.10	0.10	0.009	0.008
CASTLE PEAK3	21779	1	828	955	102	65	0.26	3.43	1.40	0.42	0.10	0.06	0.009	0.008
DIDCOT	30439	0	817	922	77	70	0.25	3.52	1.56	0.42	0.12	0.11	0.008	0.006
CASTLE PEAK2	21710	0	815	925	141	68	0.28	3.48	1.43	0.40	0.11	0.14	0.007	0.007
PEM1	99999	3	792	900	119	68	0.23	3.52	1.84	0.35	0.10	0.01	0.012	0.009
TORNESS1	22671	0	790	910	102	72	0.27	3.46	1.43	0.41	0.11	0.15	0.010	0.010
DUVHA4	20858	0	787	925	141	70	0.29	3.50	1.43	0.40	0.12	0.16	0.005	0.006
DUVHA3	20712	0	785	925	113	66	0.30	3.47	1.46	0.40	0.12	0.17	0.009	0.011
CASTLE PEAKB2	23428	0	785	895	132	72	0.25	3.46	1.43	0.44	0.13	0.14	0.009	0.006
GENESSEE2	23058	0	780	910	137	65	0.29	3.62	1.66	0.41	0.12	0.10	0.006	0.005
CASTLE PEAKB	22692	0	780	900	137	70	0.26	3.49	1.45	0.41	0.12	0.15	0.007	0.008
CASTLE PEAK4	22291	2	777	872	108	72	0.27	3.43	1.42	0.45	0.09	0.03	0.008	0.006
KEEPHILLS3	21458	0	772	895	146	73	0.28	3.40	1.40	0.40	0.11	0.13	0.008	0.005
MARATHON BRAE	23421	0	770	890	99	73	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004
TORNESS2	23075	0	770	880	122	72	0.28	3.52	1.55	0.42	0.12	0.12	0.007	0.007
PETERHEAD1	19042	0	770	895	110	71	0.28	3.47	1.46	0.40	0.14	0.20	0.006	0.008
TSING YI	18655	0	770	895	0	62	0.37	2.90	1.32	0.35	0.12	0.29	0.013	0.011
KORI2	20865	3	755	865	196	67	0.26	3.42	1.67	0.44	0.10	0.02	0.008	0.007
HINKLEY POINT	22932	2	750	885	123	67	0.27	3.60	1.70	0.42	0.12	0.05	0.007	0.007
HIGH SPEED M	23659	0	750	892	84	64	0.38	3.50	1.80	0.44	0.11	0.27	0.007	0.010
MARATHON BRAE3	23682	0	750	845	88	72	0.30	3.45	1.42	0.36	0.10	0.11	0.007	0.005
STOCK	22528	2	748	866	143	72	0.24	3.56	1.40	0.42	0.10	0.04	0.008	0.007
DUVHA5	21033	0	748	877	112	71	0.29	3.40	1.71	0.42	0.11	0.10	0.009	0.007
NUCLEAR5	21485	1	745	655	235	71	0.25	3.49	1.59	0.43	0.13	0.06	0.006	0.006
ADYS5	23224	0	745	845	98	70	0.28	3.43	1.44	0.36	0.13	0.18	0.005	0.004
TUTUKA2	22527	0	745	880	109	72	0.28	3.46	1.45	0.36	0.11	0.11	0.009	0.006
DUVHA2	20349	0	745	875	116	71	0.26	3.31	1.65	0.43	0.11	0.17	0.008	0.008
GRAIN5	18679	0	741	880	114	69	0.27	3.55	1.40	0.40	0.14	0.12	0.008	0.009
TUTUKA6	23527	0	740	860	103	72	0.26	3.51	1.50	0.41	0.11	0.13	0.009	0.005
RIHAND1	23300	0	735	850	147	68	0.25	3.41	1.47	0.42	0.11	0.15	0.006	0.005
ESCOM SPARE	20855	0	732	841	125	74	0.28	3.50	1.67	0.43	0.11	0.08	0.006	0.009
CASTLE PEAKB3	23825	0	730	860	121	70	0.27	3.49	1.50	0.43	0.12	0.19	0.006	0.005
TUTUKA3	22691	2	728	847	138	73	0.24	3.45	1.47	0.39	0.10	0.02	0.006	0.007
DUVHA1	20348	0	725	850	130	74	0.25	3.48	1.48	0.41	0.13	0.18	0.006	0.005
TUTUKA5	23500	1	723	838	157	73	0.26	3.53	1.49	0.41	0.10	0.06	0.006	0.006
TUTUKA1	22516	1	721	832	103	71	0.27	3.68	1.74	0.41	0.11	0.05	0.008	0.008
TRINIDAD1	23091	0	719	853	132	72	0.26	3.48	1.41	0.46	0.10	0.13	0.011	0.007
DRAX.COMPL1	21667	0	710	810	117	74	0.29	1.92	1.25	0.45	0.11	0.23	0.007	0.008
RINGHALS	23323	0	710	835	147	74	0.28	3.49	1.49	0.38	0.14	0.10	0.006	0.007
SUNDANCE6	20692	0	710	835	138	74	0.28	3.46	1.44	0.41	0.13	0.18	0.008	0.007
BRITOIL	23422	0	710	830	91	74	0.28	3.40	1.48	0.35	0.11	0.13	0.009	0.004
TUTUKA4	22929	2	709	834	147	69	0.24	3.45	1.38	0.37	0.09	0.03	0.007	0.008
ELM MOBILE	22078	0	701	834	120	59	0.29	3.42	1.42	0.42	0.10	0.12	0.007	0.009
NUCLEAR6	21567	3	700	795	210	75	0.24	3.43	1.62	0.43	0.12	0.01	0.008	0.005
STOCK9	19129	2	700	845	147	66	0.36	3.11	1.26	0.37	0.13	0.27	0.016	0.010
DUVHA6	22065	1	700	830	131	73	0.25	3.49	1.34	0.44	0.11	0.06	0.007	0.007
ADMIR'Y	23197	1	695	810	155	75	0.26	3.50	1.47	0.46	0.13	0.05	0.005	0.008
GRAIN4	19699	0	695	850	118	64	0.36	3.06	1.23	0.39	0.12	0.28	0.014	0.014
SUNDANCE5	19290	0	695	850	143	74	0.30	3.35	1.50	0.40	0.12	0.20	0.006	0.007
KILROOT3	19377	0	695	850	130	71	0.30	1.90	1.25	0.38	0.09	0.35	0.008	0.008
EM610STOCK12	21628	0	695	850	103	72	0.28	1.91	1.24	0.43	0.08	0.19	0.008	0.008
WILLINGTON	23121	0	695	820	141	72	0.27	3.52	1.44	0.41	0.13	0.17	0.005	0.005

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CONTRACT	FORGE	KEY	PROOF	UTS	IMP	RA	C	NI	CR	MO	V	SI	S	P
AHWAZ2	19376	0	695	850	94	67	0.37	3.06	1.33	0.38	0.12	0.29	0.011	0.012
EM610STOCK8	21922	0	692	804	92	69	0.27	1.92	1.27	0.36	0.10	0.11	0.001	0.007
MARATHON BRAE2	23661	0	680	785	102	77	0.25	3.55	1.48	0.37	0.11	0.14	0.008	0.007
EM610STOCK9	21999	2	678	788	82	65	0.25	2.01	1.32	0.40	0.10	0.04	0.003	0.010
EM610STOCK15B	21796	2	675	796	114	72	0.28	1.90	1.35	0.42	0.10	0.04	0.010	0.005
STOCK	22920	1	675	789	120	73	0.29	1.93	1.46	0.45	0.11	0.09	0.012	0.009
EM610STOCK14	21795	0	675	835	128	70	0.30	1.88	1.23	0.41	0.09	0.22	0.006	0.006
EM610STOCKC	21008	2	670	775	186	73	0.25	2.30	1.34	0.47	0.10	0.06	0.009	0.008
GRANGEMOUTH2	19725	0	669	812	90	66	0.29	1.95	1.42	0.43	0.10	0.13	0.012	0.008
COTTAM3	20091	2	665	820	176	69	0.30	2.09	1.43	0.44	0.09	0.06	0.009	0.007
DRAX.COMPLB	21668	1	665	775	196	75	0.24	2.03	1.57	0.45	0.10	0.06	0.008	0.005
CASTLE PEAK	21351	1	662	789	165	74	0.25	3.42	1.59	0.31	0.10	0.06	0.010	0.005
BLYTH8	19593	0	660	785	143	75	0.27	1.85	1.35	0.40	0.09	0.23	0.006	0.008
KIPEVU7	18960	2	657	804	75	70	0.28	2.00	1.34	0.47	0.10	0.07	0.012	0.010
ELM150	21016	2	656	796	155	71	0.26	1.96	1.34	0.42	0.12	0.06	0.011	0.010
BANGLADESH	22698	0	656	762	99	69	0.25	1.89	1.31	0.39	0.09	0.26	0.007	0.008
EM610CSTOCK11	21236	3	650	802	94	70	0.32	1.93	1.37	0.43	0.09	0.03	0.010	0.006
LITTLEBROOK3	20422	2	650	800	75	51	0.38	2.86	1.33	0.39	0.13	0.35	0.015	0.017
EM610BSTOCK8C	21032	2	650	800	126	72	0.28	1.84	1.24	0.37	0.09	0.24	0.009	0.003
MEI BHOPAL	19052	0	650	805	108	72	0.26	1.80	1.17	0.41	0.00	0.25	0.016	0.018
EM610STOCK13	21459	0	650	772	95	72	0.29	1.94	1.29	0.42	0.08	0.18	0.010	0.006
EM610STOCK10	21010	2	643	777	120	70	0.26	1.94	1.42	0.43	0.09	0.06	0.012	0.007
INCE6	19128	0	640	765	167	69	0.28	2.05	1.21	0.43	0.13	0.10	0.014	0.006
KILROOT1	19190	0	635	770	167	75	0.24	3.24	1.46	0.38	0.11	0.29	0.010	0.012
KILROOT	18606	0	630	780	86	59	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007
NIGERIA	20914	0	623	756	88	70	0.26	2.00	1.31	0.42	0.10	0.08	0.013	0.005
GRANGEMOUTH	18607	0	620	770	82	60	0.26	1.90	1.23	0.46	0.11	0.12	0.011	0.007
LITTLEBROOK2	19004	0	610	735	148	72	0.27	2.08	1.22	0.36	0.15	0.11	0.011	0.008
BERYL1	21420	2	598	726	112	73	0.25	1.92	1.41	0.42	0.09	0.03	0.009	0.011
NIGERIAN NEWS	21039	0	593	726	125	73	0.26	2.05	1.33	0.40	0.09	0.08	0.010	0.005
ABADAN	19019	0	585	695	163	75	0.30	2.00	1.26	0.40	0.11	0.12	0.010	0.007
KILROOT4	19724	0	585	770	150	75	0.26	1.94	1.24	0.42	0.11	0.08	0.007	0.017
QUAD OLYMPUS1	19326	0	570	770	107	71	0.27	1.80	1.31	0.42	0.10	0.23	0.008	0.009

End of Report

REPORT INDEXED ON REDUCTION OF AREA

Indexed on Reduction of Area

CONTRACT	FORGE	KEY	RA	EL	IMP	FATT	PRF	C	SI	MN	S	P	NI	CR	MO
MARATHON BRAE2	23661	0	77	21	102	-113	680	0.25	0.14	0.22	0.008	0.007	3.55	1.48	0.37
KILROOT1	19190	0	75	24	167	10	635	0.24	0.29	0.41	0.010	0.012	3.24	1.46	0.38
NUCLEAR6	21567	3	75	23	210	-100	700	0.24	0.01	0.25	0.008	0.005	3.43	1.62	0.43
ABADAN	19019	0	75	23	163	-20	585	0.30	0.12	0.19	0.010	0.007	2.00	1.26	0.40
BLYTH8	19593	0	75	23	143	-77	660	0.27	0.23	0.20	0.006	0.008	1.85	1.35	0.40
ADMIR'Y	23197	1	75	21	155	-100	695	0.25	0.05	0.32	0.005	0.008	3.50	1.47	0.46
KILROOT4	19724	0	75	20	150	-89	585	0.26	0.08	0.16	0.007	0.017	1.94	1.24	0.42
DRAX.COMPLB	21668	1	75	19	196	-80	665	0.24	0.06	0.47	0.008	0.005	2.03	1.57	0.45
RINGHALS	23323	0	74	23	147	-100	710	0.28	0.10	0.25	0.006	0.007	3.49	1.49	0.38
SUNDANCE5	19290	0	74	23	143	-95	695	0.30	0.20	0.20	0.006	0.007	3.35	1.50	0.40
CASTLE PEAK	21351	1	74	22	165	999	662	0.25	0.06	0.24	0.010	0.005	3.42	1.59	0.31
ESCOM SPARE	20855	0	74	22	125	-100	732	0.28	0.08	0.22	0.006	0.009	3.50	1.67	0.43
BRITOIL	23422	0	74	22	91	-100	710	0.28	0.13	0.30	0.009	0.004	3.40	1.48	0.35
SUNDANCE6	20692	0	74	21	138	-105	710	0.28	0.18	0.26	0.008	0.007	3.46	1.44	0.41
DUVHA1	20348	0	74	21	130	-90	725	0.25	0.18	0.14	0.006	0.005	3.48	1.48	0.41
DRAX.COMPL1	21667	0	74	21	117	-80	710	0.29	0.23	0.36	0.007	0.008	1.92	1.25	0.45
NIGERIAN NEWS	21039	0	73	24	125	-60	593	0.26	0.08	0.23	0.010	0.005	2.05	1.33	0.40
BERYL1	21420	2	73	22	112	999	598	0.25	0.03	0.35	0.009	0.011	1.92	1.41	0.42
EM610STOCKC	21008	2	73	21	186	-74	670	0.25	0.06	0.55	0.009	0.008	2.30	1.34	0.47
STOCK	22920	1	73	21	120	-90	675	0.29	0.09	0.44	0.012	0.009	1.93	1.46	0.45
KEEPHILLS3	21458	0	73	20	146	-132	772	0.28	0.13	0.22	0.008	0.005	3.40	1.40	0.40
MARATHON BRAE	23421	0	73	20	99	-90	770	0.28	0.13	0.30	0.009	0.004	3.40	1.48	0.35
TUTUKA3	22691	2	73	19	138	-136	728	0.24	0.02	0.34	0.006	0.007	3.45	1.47	0.39
TUTUKA5	23500	1	73	18	157	-115	723	0.26	0.06	0.30	0.006	0.006	3.53	1.49	0.41
DUVHA6	22065	1	73	18	131	-80	700	0.25	0.06	0.29	0.007	0.007	3.49	1.34	0.44
LITTLEBROOK2	19004	0	72	28	148	-40	610	0.27	0.11	0.22	0.011	0.008	2.08	1.22	0.36
EM610STOCK13	21459	0	72	23	95	-90	650	0.29	0.18	0.40	0.010	0.006	1.94	1.29	0.42
TRINIDAD1	23091	0	72	21	132	-57	719	0.26	0.13	0.32	0.011	0.007	3.48	1.41	0.46
EM610STOCK15B	21796	2	72	21	114	-70	675	0.28	0.04	0.32	0.010	0.005	1.90	1.35	0.42
MEI BHOPAL	19052	0	72	21	108	999	650	0.26	0.25	0.47	0.016	0.018	1.80	1.17	0.41
EM610STOCK12	21628	0	72	21	103	-53	695	0.28	0.19	0.37	0.008	0.008	1.91	1.24	0.43
TUTUKA6	23527	0	72	21	103	-120	740	0.26	0.13	0.21	0.009	0.005	3.51	1.50	0.41
MARATHON BRAE3	23682	0	72	21	88	-121	750	0.30	0.11	0.19	0.007	0.005	3.45	1.42	0.36
WILLINGTON	23121	0	72	20	141	-105	695	0.27	0.17	0.24	0.005	0.005	3.52	1.44	0.41
EM610BSTOCK8C	21032	2	72	20	126	-35	650	0.28	0.24	0.18	0.009	0.003	1.84	1.24	0.37
TORNESS2	23075	0	72	20	122	-105	770	0.28	0.12	0.21	0.007	0.007	3.52	1.55	0.42
TUTUKA2	22527	0	72	20	109	-117	745	0.28	0.11	0.19	0.009	0.006	3.46	1.45	0.36
CASTLE PEAK4	22291	2	72	20	108	-90	777	0.27	0.03	0.29	0.008	0.006	3.43	1.42	0.45
TORNESS1	22671	0	72	20	102	-102	790	0.27	0.15	0.18	0.010	0.010	3.46	1.43	0.41
STOCK	22528	2	72	18	143	-120	748	0.24	0.04	0.36	0.008	0.007	3.56	1.40	0.42
CASTLE PEAKB2	23428	0	72	18	132	-107	785	0.25	0.14	0.20	0.009	0.006	3.46	1.43	0.44
KILROOT3	19377	0	71	23	130	-57	695	0.30	0.35	0.17	0.008	0.008	1.90	1.25	0.38
ELM150	21016	2	71	22	155	-40	656	0.26	0.06	0.40	0.011	0.010	1.96	1.34	0.42
NUCLEAR5	21485	1	71	21	235	-95	745	0.25	0.06	0.27	0.006	0.006	3.49	1.59	0.43
DUVHA5	21033	0	71	21	112	-110	748	0.29	0.10	0.28	0.009	0.007	3.40	1.71	0.42
QUAD OLYMPUS1	19326	0	71	21	107	-55	570	0.27	0.23	0.23	0.008	0.009	1.80	1.31	0.42
PETERHEAD1	19042	0	71	20	110	-64	770	0.28	0.20	0.34	0.006	0.008	3.47	1.46	0.40
TUTUKA1	22516	1	71	20	103	-85	721	0.27	0.05	0.31	0.008	0.008	3.68	1.74	0.41
DUVHA2	20349	0	71	19	116	-100	745	0.26	0.17	0.28	0.008	0.008	3.31	1.65	0.43
NIGERIA	20914	0	70	22	88	-44	623	0.26	0.08	0.21	0.013	0.005	2.00	1.31	0.42
EM610STOCK10	21010	2	70	21	120	-79	643	0.26	0.06	0.41	0.012	0.007	1.94	1.42	0.43
ADYSS	23224	0	70	21	98	-114	745	0.28	0.18	0.21	0.005	0.004	3.43	1.44	0.36
CASTLE PEAKB	22692	0	70	20	137	-105	780	0.26	0.15	0.20	0.007	0.008	3.49	1.45	0.41

Indexed on Reduction of Area

CONTRACT	FORGE	KEY	RA	EL	IMP	FATT	PRF	C	SI	MN	S	P	NI	CR	MO
EM610STOCK14	21795	0	70	20	128	-66	675	0.30	0.22	0.23	0.006	0.006	1.88	1.23	0.41
CASTLE PEAKB3	23825	0	70	20	121	-89	730	0.27	0.19	0.25	0.006	0.005	3.49	1.50	0.43
EM610CSTOCK11	21236	3	70	20	94	-55	650	0.32	0.03	0.36	0.010	0.006	1.93	1.37	0.43
KIPEVU7	18960	2	70	20	75	-10	657	0.28	0.07	0.43	0.012	0.010	2.00	1.34	0.47
DUVHA4	20858	0	70	19	141	-87	787	0.29	0.16	0.25	0.005	0.006	3.50	1.43	0.40
DIDCOT	30439	0	70	17	77	999	817	0.25	0.11	0.24	0.008	0.006	3.52	1.56	0.42
INCE6	19128	0	69	24	167	-20	640	0.28	0.10	0.23	0.014	0.006	2.05	1.21	0.43
BANGLADESH	22698	0	69	22	99	999	656	0.25	0.26	0.42	0.007	0.008	1.89	1.31	0.39
EM610STOCK8	21922	0	69	20	92	999	692	0.27	0.11	0.36	0.001	0.007	1.92	1.27	0.36
COTTAM3	20091	2	69	19	176	-120	665	0.30	0.06	0.39	0.009	0.007	2.09	1.43	0.44
TUTUKA4	22929	2	69	19	147	-121	709	0.24	0.03	0.28	0.007	0.008	3.45	1.38	0.37
GRAIN5	18679	0	69	19	114	-83	741	0.27	0.12	0.33	0.008	0.009	3.55	1.40	0.40
RIHAND1	23300	0	68	20	147	-106	735	0.25	0.15	0.19	0.006	0.005	3.41	1.47	0.42
CASTLE PEAK2	21710	0	68	18	141	-100	815	0.28	0.14	0.23	0.007	0.007	3.48	1.43	0.40
PEM1	99999	3	68	18	119	999	792	0.23	0.01	0.28	0.012	0.009	3.52	1.84	0.35
AHWAZ2	19376	0	67	21	94	30	695	0.37	0.29	0.32	0.011	0.012	3.06	1.33	0.38
KORI2	20865	3	67	19	196	-88	755	0.26	0.02	0.25	0.008	0.007	3.42	1.67	0.44
HINKLEY POINT	22932	2	67	19	123	999	750	0.27	0.05	0.27	0.007	0.007	3.60	1.70	0.42
STOCK9	19129	2	66	20	147	40	700	0.36	0.27	0.42	0.016	0.010	3.11	1.26	0.37
NATIONAL SPARE	20194	2	66	19	86	-70	860	0.26	0.03	0.40	0.008	0.008	3.46	1.40	0.45
DUVHA3	20712	0	66	18	113	-90	785	0.30	0.17	0.22	0.009	0.011	3.47	1.46	0.40
GRAIN1	18038	0	66	18	107	-50	850	0.21	0.10	0.20	0.009	0.008	3.42	1.47	0.50
GRANGEMOUTH2	19725	0	66	18	90	-35	669	0.29	0.13	0.38	0.012	0.008	1.95	1.42	0.43
EM610STOCK9	21999	2	65	19	82	999	678	0.25	0.04	0.32	0.003	0.010	2.01	1.32	0.40
CASTLE PEAK3	21779	1	65	18	102	999	828	0.26	0.06	0.27	0.009	0.008	3.43	1.40	0.42
GENESSEE2	23058	0	65	17	137	-101	780	0.29	0.10	0.30	0.006	0.005	3.62	1.66	0.41
GRAIN4	19699	0	64	21	118	999	695	0.36	0.28	0.38	0.014	0.014	3.06	1.23	0.39
HIGH SPEED M	23659	0	64	17	84	-71	750	0.38	0.27	0.28	0.007	0.010	3.50	1.80	0.44
TSING YI	18655	0	62	21	0	999	770	0.37	0.29	0.41	0.013	0.011	2.90	1.32	0.35
GRANGEMOUTH	18607	0	60	20	82	-70	620	0.26	0.12	0.35	0.011	0.007	1.90	1.23	0.46
ELM MOBILE	22078	0	59	21	120	-90	701	0.29	0.12	0.30	0.007	0.009	3.42	1.42	0.42
KILROOT	18606	0	59	18	86	-10	630	0.26	0.12	0.35	0.011	0.007	1.90	1.23	0.46
LITTLEBROOK3	20422	2	51	20	75	25	650	0.38	0.35	0.38	0.015	0.017	2.86	1.33	0.39

End of Report

REPORT INDEXED ON SUPPLIER

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CONTRACT	SUPPLIER	FORGE	KEY	IMP	FATT	PRF	RA	C	SI	NI	CR	S	P
EM610BSTOCK8C	BSC	21032	2	126	-35	650	72	0.28	0.24	1.84	1.24	0.009	0.003
ADMIR'Y	BSC	23197	1	155	-100	695	75	0.26	0.05	3.50	1.47	0.005	0.008
CASTLE PEAK3	BSC	21779	1	102	999	828	65	0.26	0.06	3.43	1.40	0.009	0.008
EM610STOCK13	BSC	21459	0	95	-90	650	72	0.29	0.18	1.94	1.29	0.010	0.006
CASTLE PEAK2	BSC	21710	0	141	-100	815	68	0.28	0.14	3.48	1.43	0.007	0.007
TORNESS1	BSC	22671	0	102	-102	790	72	0.27	0.15	3.46	1.43	0.010	0.010
DUVHA1	BSC	20348	0	130	-90	725	74	0.25	0.18	3.48	1.48	0.006	0.005
ABADAN	BSC	19019	0	163	-20	585	75	0.30	0.12	2.00	1.26	0.010	0.007
KEEPHILLS3	BSC	21458	0	146	-132	772	73	0.28	0.13	3.40	1.40	0.008	0.005
FETERHEAD1	BSC	19042	0	110	-64	770	71	0.28	0.20	3.47	1.46	0.006	0.008
RIHAND1	BSC	23300	0	147	-106	735	68	0.25	0.15	3.41	1.47	0.006	0.005
MARATHON BRAE	BSC	23421	0	99	-90	770	73	0.28	0.13	3.40	1.48	0.009	0.004
BRITOIL	BSC	23422	0	91	-100	710	74	0.28	0.13	3.40	1.48	0.009	0.004
TORNESS2	BSC	23075	0	122	-105	770	72	0.28	0.12	3.52	1.55	0.007	0.007
GRAIN1	BSC	18038	0	107	-50	850	66	0.21	0.10	3.42	1.47	0.009	0.008
QUAD OLYMPUS1	BSC	19326	0	107	-55	570	71	0.27	0.23	1.80	1.31	0.008	0.009
CASTLE PEAKB2	BSC	23428	0	132	-107	785	72	0.25	0.14	3.46	1.43	0.009	0.006
KILROOT3	BSC	19377	0	130	-57	695	71	0.30	0.35	1.90	1.25	0.008	0.008
RINGHALS	BSC	23323	0	147	-100	710	74	0.28	0.10	3.49	1.49	0.006	0.007
ADYSS	BSC	23224	0	98	-114	745	70	0.28	0.18	3.43	1.44	0.005	0.004
SUNDANCE6	BSC	20692	0	138	-105	710	74	0.28	0.18	3.46	1.44	0.008	0.007
EM610STOCK14	BSC	21795	0	128	-66	675	70	0.30	0.22	1.88	1.23	0.006	0.006
DUVHA3	BSC	20712	0	113	-90	785	66	0.30	0.17	3.47	1.46	0.009	0.011
SUNDANCE5	BSC	19290	0	143	-95	695	74	0.30	0.20	3.35	1.50	0.006	0.007
BLYTH8	BSC	19593	0	143	-77	660	75	0.27	0.23	1.85	1.35	0.006	0.008
KILROOT4	BSC	19724	0	150	-89	585	75	0.26	0.08	1.94	1.24	0.007	0.017
TUTUKA2	BSC	22527	0	109	-117	745	72	0.28	0.11	3.46	1.45	0.009	0.006
WILLINGTON	BSC	23121	0	141	-105	695	72	0.27	0.17	3.52	1.44	0.005	0.005
GRAIN5	BSC	18679	0	114	-83	741	69	0.27	0.12	3.55	1.40	0.008	0.009
DUVHA4	BSC	20858	0	141	-87	787	70	0.29	0.16	3.50	1.43	0.005	0.006
CASTLE PEAKB	BSC	22692	0	137	-105	780	70	0.26	0.15	3.49	1.45	0.007	0.008
EM610STOCK12	BSC	21628	0	103	-53	695	72	0.28	0.19	1.91	1.24	0.008	0.008
DRAX.COMPL1	BSC	21667	0	117	-80	710	74	0.29	0.23	1.92	1.25	0.007	0.008
MEI BHOPAL	COCKERILL	19052	0	108	999	650	72	0.26	0.25	1.80	1.17	0.016	0.018
PEM1	CREUSOT-LOIR	99999	3	119	999	792	68	0.23	0.01	3.52	1.84	0.012	0.009
GENESSEE2	CREUSOT-LOIR	23058	0	137	-101	780	65	0.29	0.10	3.62	1.66	0.006	0.005
HIGH SPEED M	FOMAS	23659	0	84	-71	750	64	0.38	0.27	3.50	1.80	0.007	0.010
MARATHON BRAE2	FORGEM	23661	0	102	-113	680	77	0.25	0.14	3.55	1.48	0.008	0.007
CASTLE PEAKB3	FORGEM	23825	0	121	-89	730	70	0.27	0.19	3.49	1.50	0.006	0.005
MARATHON BRAE3	FORGEM	23682	0	88	-121	750	72	0.30	0.11	3.45	1.42	0.007	0.005
DIDCOT	FORGEM	30439	0	77	999	817	70	0.25	0.11	3.52	1.56	0.008	0.006
TUTUKA6	FORGEM	23527	0	103	-120	740	72	0.26	0.13	3.51	1.50	0.009	0.005
EM610STOCK15B	FRIED KRUPP	21796	2	114	-70	675	72	0.28	0.04	1.90	1.35	0.010	0.005
BERYL1	FRIED KRUPP	21420	2	112	999	598	73	0.25	0.03	1.92	1.41	0.009	0.011
KIPEVU7	FRIED KRUPP	18960	2	75	-10	657	70	0.28	0.07	2.00	1.34	0.012	0.010
CASTLE PEAK4	FRIED KRUPP	22291	2	108	-90	777	72	0.27	0.03	3.43	1.42	0.008	0.006
COTTAM3	FRIED KRUPP	20091	2	176	-120	665	69	0.30	0.06	2.09	1.43	0.009	0.007
NATIONAL SPARE	FRIED KRUPP	20194	2	86	-70	860	66	0.26	0.03	3.46	1.40	0.008	0.008
STOCK	FRIED KRUPP	22920	1	120	-90	675	73	0.29	0.09	1.93	1.46	0.012	0.009
GRANGEMOUTH2	FRIED KRUPP	19725	0	90	-35	669	66	0.29	0.13	1.95	1.42	0.012	0.008
ELM MOBILE	FRIED KRUPP	22078	0	120	-90	701	59	0.29	0.12	3.42	1.42	0.007	0.009
TRINIDAD1	FRIED KRUPP	23091	0	132	-57	719	72	0.26	0.13	3.48	1.41	0.011	0.007
LITTLEBROOK3	GOLODETZ	20422	2	75	25	650	51	0.38	0.35	2.86	1.33	0.015	0.017

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CONTRACT	SUPPLIER	FORGE	KEY	IMP	FATT	PRF	RA	C	SI	NI	CR	S	P
STOCK9	GOLODETZ	19129	2	147	40	700	66	0.36	0.27	3.11	1.26	0.016	0.010
GRAIN4	GOLODETZ	19699	0	118	999	695	64	0.36	0.28	3.06	1.23	0.014	0.014
AHWAZ2	GOLODETZ	19376	0	94	30	695	67	0.37	0.29	3.06	1.33	0.011	0.012
KILROOT1	GOLODETZ	19190	0	167	10	635	75	0.24	0.29	3.24	1.46	0.010	0.012
TSING YI	GOLODETZ	18655	0	0	999	770	62	0.37	0.29	2.90	1.32	0.013	0.011
BANGLADESH	ITALSIDER	22698	0	99	999	656	69	0.25	0.26	1.89	1.31	0.007	0.008
EM610CSTOCK11	KRUPP	21236	3	94	-55	650	70	0.32	0.03	1.93	1.37	0.010	0.006
ELM15G	KRUPP	21016	2	155	-40	656	71	0.26	0.06	1.96	1.34	0.011	0.010
EM610STOCK10	KRUPP	21010	2	120	-79	643	70	0.26	0.06	1.94	1.42	0.012	0.007
CASTLE PEAK	KRUPP	21351	1	165	999	662	74	0.25	0.06	3.42	1.59	0.010	0.005
KORI2	MITSUI	20865	3	196	-88	755	67	0.26	0.02	3.42	1.67	0.008	0.007
NUCLEAR6	MITSUI	21567	3	210	-100	700	75	0.24	0.01	3.43	1.62	0.008	0.005
NUCLEAR5	MITSUI	21485	1	235	-95	745	71	0.25	0.06	3.49	1.59	0.006	0.006
KILROOT	RHEINSTAHL	18606	0	86	-10	630	59	0.26	0.12	1.90	1.23	0.011	0.007
GRANGEMOUTH	RHEINSTAHL	18607	0	82	-70	620	60	0.26	0.12	1.90	1.23	0.011	0.007
NIGERIA	ROCHLING	20914	0	88	-44	623	70	0.26	0.08	2.00	1.31	0.013	0.005
NIGERIAN NEWS	ROCHLING	21039	0	125	-60	593	73	0.26	0.08	2.05	1.33	0.010	0.005
INCE6	ROCHLING	19128	0	167	-20	640	69	0.28	0.10	2.05	1.21	0.014	0.006
LITTLEBROOK2	ROCHLING	19004	0	148	-40	610	72	0.27	0.11	2.08	1.22	0.011	0.008
ESCOM SPARE	ROCHLING	20855	0	125	-100	732	74	0.28	0.08	3.50	1.67	0.006	0.009
TUTUKA3	TERNI	22691	1	138	-136	728	73	0.24	0.02	3.45	1.47	0.006	0.007
STOCE	TERNI	22528	1	143	-120	748	72	0.24	0.04	3.56	1.40	0.008	0.007
TUTUKA4	TERNI	22929	2	147	-121	709	69	0.24	0.03	3.45	1.38	0.007	0.008
EM610STOCKC	TERNI	21008	2	186	-74	670	73	0.25	0.06	2.30	1.34	0.009	0.008
DUVHA6	TERNI	22065	1	131	-80	700	73	0.25	0.06	3.49	1.34	0.007	0.007
TUTUKA5	TERNI	23500	1	157	-115	713	73	0.26	0.06	3.53	1.49	0.006	0.006
DRAX.COMPLB	TERNI	21668	1	196	-80	665	75	0.24	0.06	2.03	1.57	0.008	0.005
HINKLEY POINT	THYSSEN	22932	2	123	999	750	67	0.27	0.05	3.60	1.70	0.007	0.007
TUTUKA1	THYSSEN	22516	1	103	-85	721	71	0.27	0.05	3.68	1.74	0.008	0.008
DUVHA5	THYSSEN	21033	0	112	-110	748	71	0.29	0.10	3.40	1.71	0.009	0.007
DUVHA2	THYSSEN	20349	0	116	-100	745	71	0.26	0.17	3.31	1.65	0.008	0.008
EM610STOCK9	VON ROLL	21999	2	82	999	678	65	0.25	0.04	2.01	1.32	0.003	0.010
EM610STOCK8	VON ROLL	21922	0	92	999	692	69	0.27	0.11	1.92	1.27	0.001	0.007

End of Report

APPENDIX B

QUERY FILE FOR REPORT INDEXED ON KEY

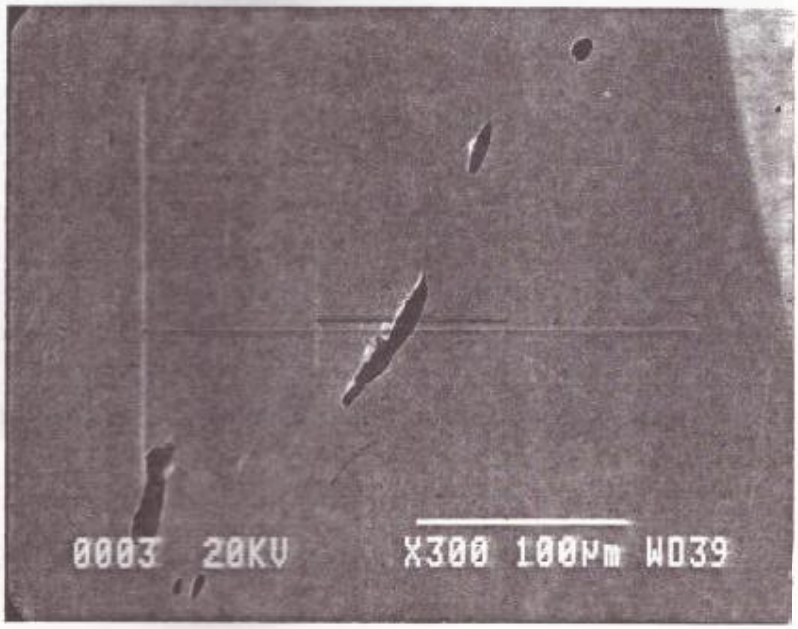
```
* dBASE IV .QBE file 8
CLOSE DATABASES
SELECT 1
USE ROTORS.DBF
SET EXACT ON
SET FILTER TO
QBE___SAFE = SET("SAFETY")
QBE___CATA = SET("CATALOG")
SET SAFETY OFF
SET CATALOG OFF
GO TOP
IF RECCOUNT() > 1
QBE___12 = '.\'+LTRIM(STR(RAND(-1)*100000000,8))
SORT TO &QBE___12 ON KEY/D,SI/A
USE &QBE___12 NOSAVE NOUPDATE
ENDIF
SET SAFETY &QBE___SAFE
SET CATALOG &QBE___CATA
GO TOP
```

APPENDIX C

CHEMICAL ANALYSES OF ROTOR SHAFT SAMPLES

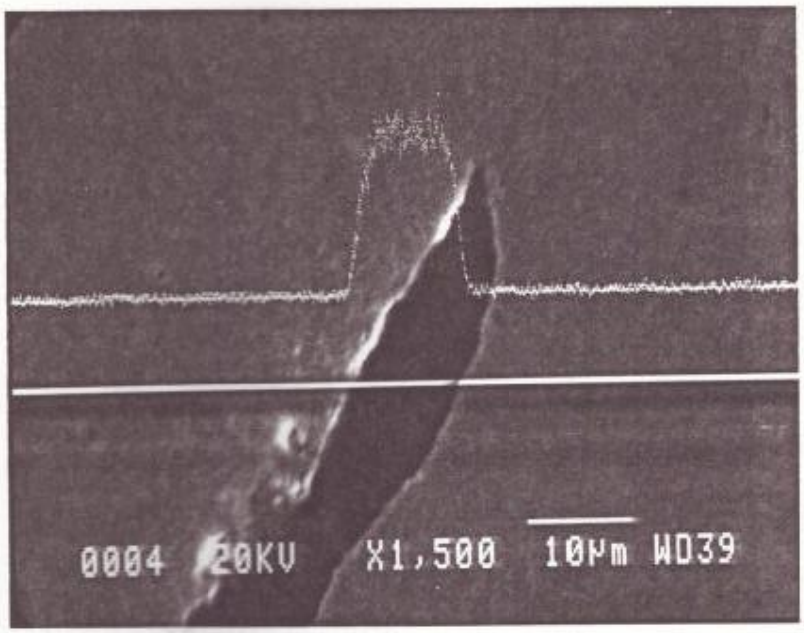
SAMPLE 1: 'LOW' IN SILICON

Photograph of a Typical Inclusion in the Sample



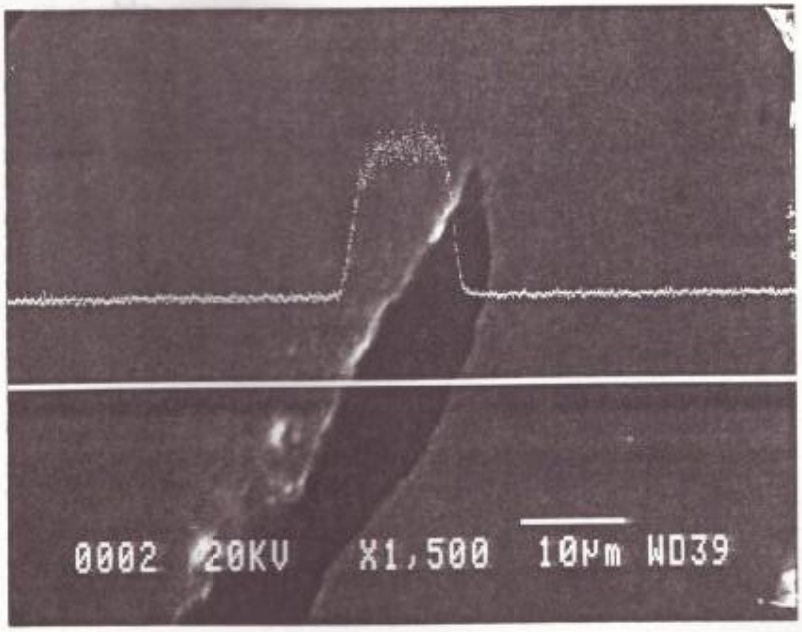
Sample 1 - 45%

Photograph of a Sulphur Scan across the Inclusion



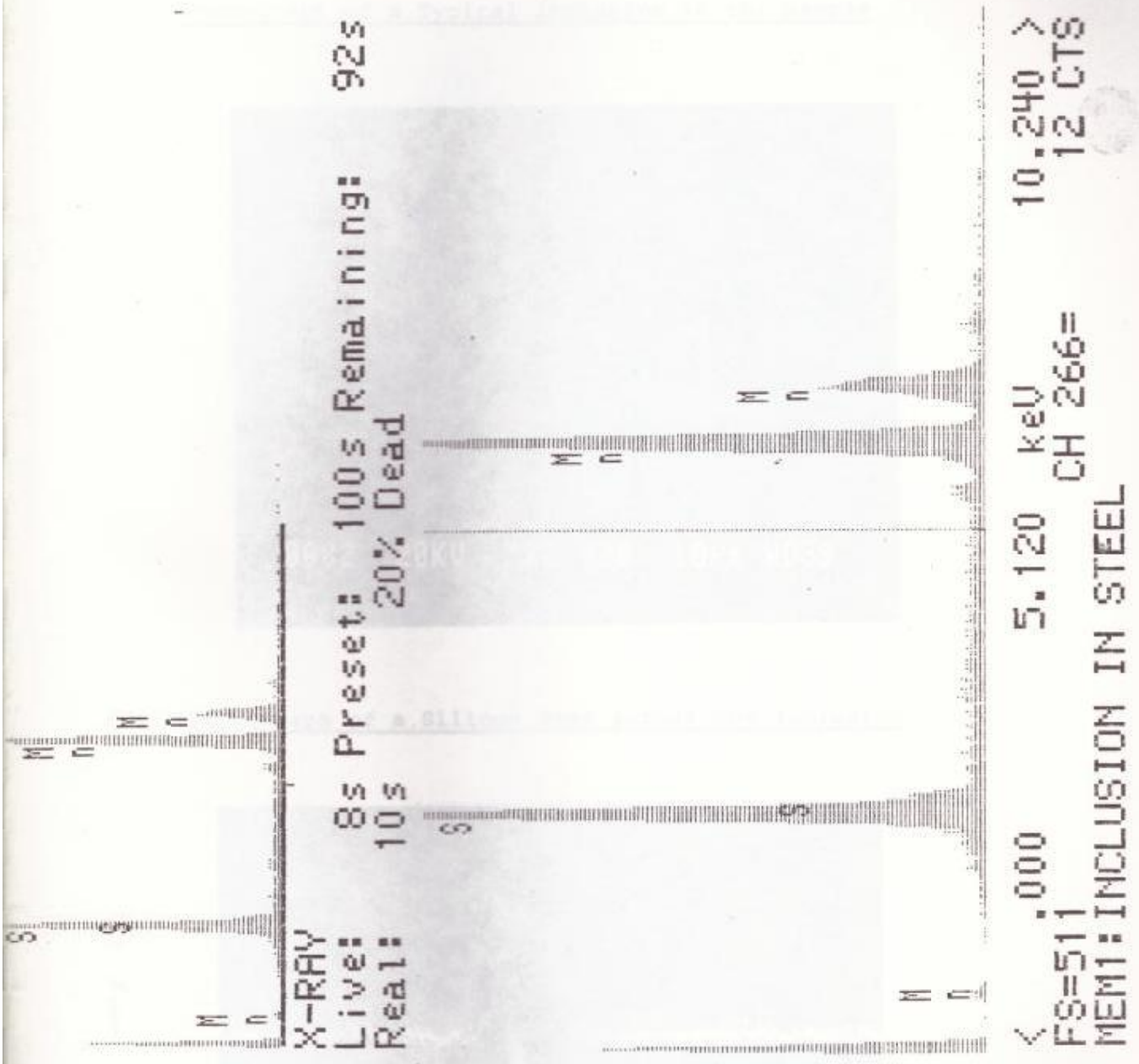
Sulphur Scan
Sample 1
4539

Photograph of a Manganese Scan across the Inclusion



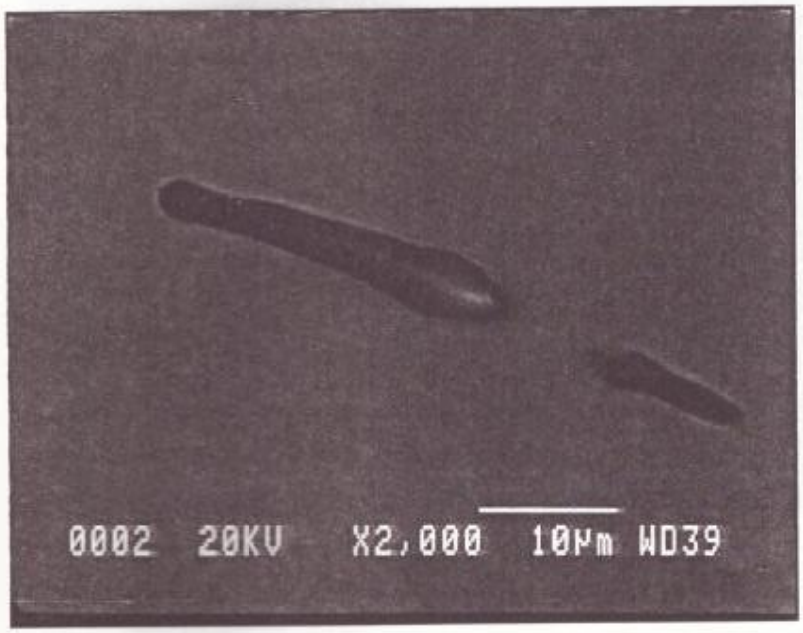
Mn dist scan, sample 1
4539

Chemical Analysis of the Inclusion

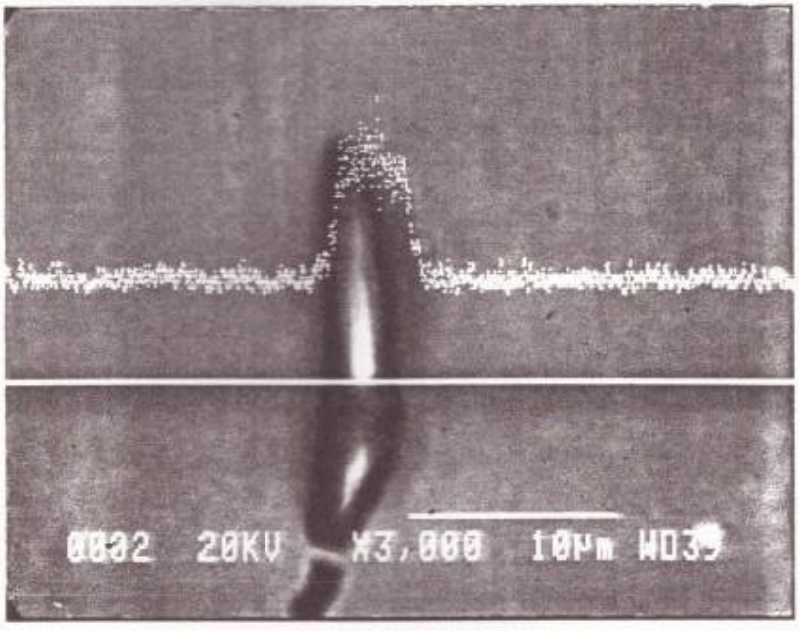


SAMPLE 2: 'HIGH' IN SILICON

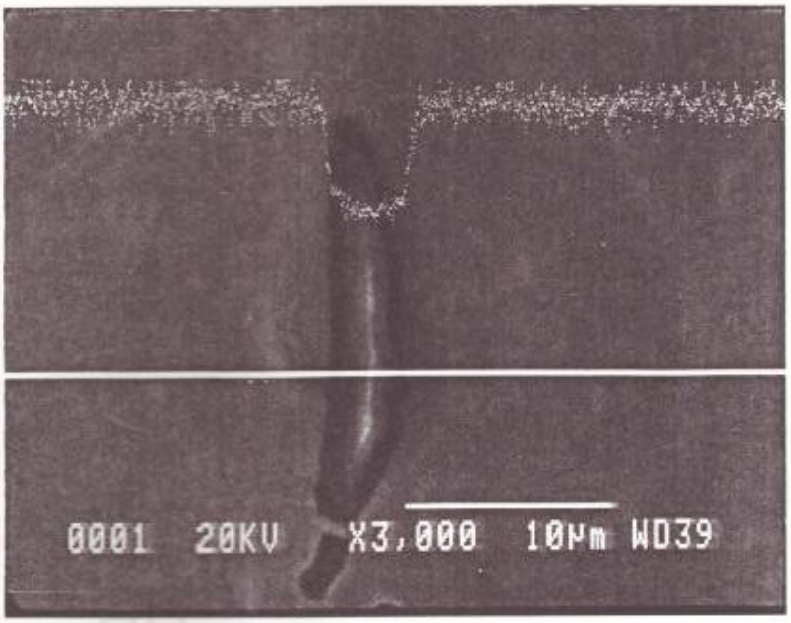
Photograph of a Typical Inclusion in the Sample



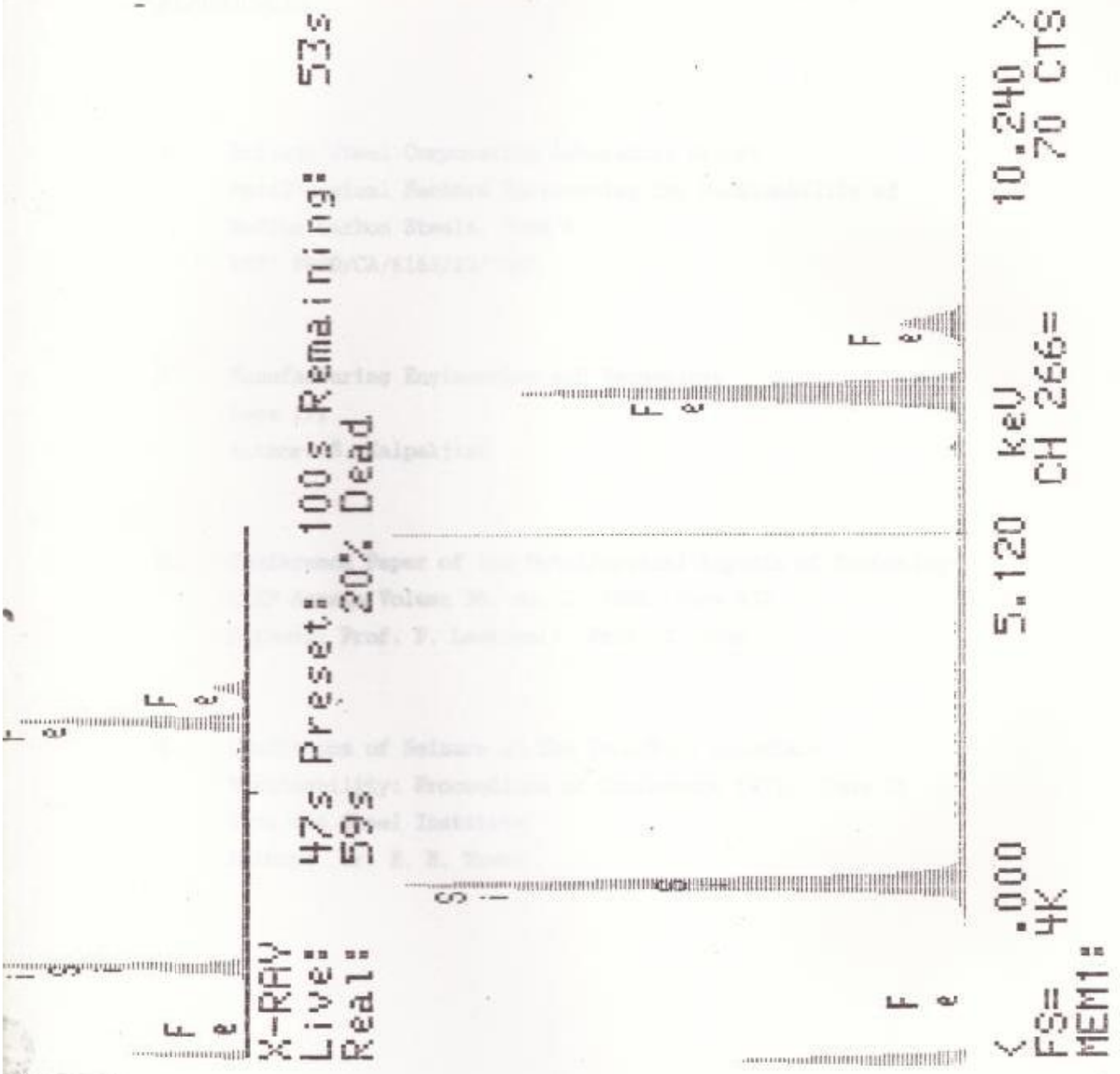
Photograph of a Silicon Scan across the Inclusion



Photograph of an Iron Scan across the Inclusion



Chemical Analysis of the Inclusion



APPENDIX D

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