No. 3

電気製鋼技術コース
帰国研修員巡回指導報告書

昭和60年11月

国際協力事業団
研修事業部

昭和60年度帰国研修員巡回指導

電気製鋼技術コース
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はじめに

この報告書は、国際協力事業団が実施した集団「電気製鋼技術」コースに参加した帰国研修員に対するフォロー・アップ事業の一環として、帰国研修員の所属機関等を訪問し、現地での技術指導を行うとともに、あわせてわが国で実施した研修の成果を測定し、もって、当該研修分野に係る当該国の技術的問題点及びニーズを把握するため、昭和６０年１０月７日から同１０月２８日までの２２日間、トルコ、エジプト、スリランカの３ケ国に派遣した巡回指導班の報告をとりまとめたものである。

本報告書により、当該分野における各国の実情、帰国研修員の活動状況、彼らが抱えている諸問題及び研修にかかる要望事項等について関係各位のさらに深いご理解をいただき、今後の研修コースの改善に資すれば幸いである。

なお、本件の実施に御協力を賜った外務省、大同特殊鋼㈱、愛知製鋼㈱、及び現地において、数々のご指導とご協力を賜った在外公館並びに関係機関に深甚の謝意を表したい。

昭和６０年１１月

研修事業部長

2. 巡回指導・調査の概要

(1) 指導・調査対象コース名

電気製鋼技術集団研修コース

(2) 指導・調査対象国

トルコ、エジプト、スリランカ

(3) 期　間

昭和60年10月7日～昭和60年10月28日

(4) 指導班構成及び業務分担

団　長　大同特殊鋼㈱
海外技術協力部長代理　下　郷　寿太郎
（技術指導）

団　員　愛知製鋼㈱
第一生産技術部主任　小　松　柳　三
（技術指導）

団　員　国際協力事業団名古屋国際研修センター　竹　内　寛　治
（業務全般の補完調整及び当班に係る会計業務）

(5) 指導班の目的

本巡回指導は「帰国研修員巡回指導班派遣要鋼」に基づき、トルコ、エジプト及びスリランカの電気製鋼技術集団研修コース帰国研修員及びその所属機関、並びに当該国の技術協力窓口機関を対象に、帰国研修員の活動状況、日本での研修効果測定、当該国の電気製鋼技術の水準、所属先の現状と技術的問題点、当該国の研修に対するニーズ等を調査し、今後の研修プログラム及び帰国研修員のフォロー・アップ等本コースの改善に資する。

また、所属先の現状と技術的問題点に関し、改善可能なものに対して助言をすると共に、帰国研修員等電気製鋼分野の関係者等に対し、わが国の最近の実情について技術セミナーを実施し、訪問国に対し当該分野の開発・発展の一助となることを目的として派遣されたものである。

3. 本コースの背景

鉄鋼は常に金属生産の主位を占めてきた。今日、世界の文化および経済の進展は鉄鋼生産に極めて密接に関係し、その生産方式、生産量等により各国の文化、経済の水準を推測し得る。

1984年には世界生産量（粗鋼）は約7億800万トンであり、うち、わが国を含めた主要国が

８９％を占め（日本が約１５％）ている。JICA関係途上国は数パーセントでブラジル、インド等を除けば極めて少ない。

近年多くの途上国において鉄鋼を一部自給すべく工業開発の中で可成りウエイトを置いている。特にスクラップを主体とした電気炉による製鋼法は小規模な生産が可能であること等により注目されており、JICA関係途上国の約３０ケ国において実施されている。またその電気炉の規模は５トン炉（エチオピア）から200トン炉（ヴェネズエラ）と種々であるが２５トン～100炉が主流である。

本コースは、かかる諸事情を考慮し、昭和５１年度に開設され、昭和５９年度現在、帰国研修員の累計は１８ケ国８８名である。途上国の中には可成り高いレベルに達しているブラジル、インド等と多くの問題点を持っているエチオピア、タンザニア等との差は大きい。本コースは主要原料であるスクラップから電気炉による製鋼技術、鋼材製造迄、日本語研修（約７５Ｈ）を含めて５ケ月間の研修を実施、また、近年多くの途上国で開始されている連続鋳造法も主要テーマとして実施している。

今回、巡回指導班は、以上の諸事情を背景において、派遣国であるトルコ、エジプトおよびスリランカに対し、各国のレベル、ニーズ、問題点等の調査により本コースへの対応と現地での技術指導が実施され、関係各位のご協力のか蔭げにより現地にて約100名（記録上は８６名）に会見でき、種々ご指導を載き感謝に絶えません。

4. 日　　程

月日曜	旅　　程	訪　問　先	内　容	会見者
10 7 月	名古屋 (ＪＮＲ) 東京 東京 21:00 (AF273) 05:55 パリ	1。事業団本部、 1。移動(出発)(第一訪問国、トルコへ)	1。出国手続、挨拶、2。出国	飯島次長他
8 火	パリ 09:25 (LH143) 10:50 ミュンヘン ミュンヘン (LH322) アンカラ着 11:40 15:30 空港(公用車)ホテル	1。移動 1。到着	1。移動 1。到着	広瀬参事官他
9 水	ホテル(公用車)訪問先	1。日本大使館 2。計画庁 3。移動(アンカラから約250 キロ)(Karabok)	1。挨拶・日程確認 2。移動	Mrs. Meral Orgun 他
10 木	ホテル(公用車)訪問先	1。トルコ製鉄所(Karabok) 2。移動	1。見学・質疑応答 2。セミナー 3。移動	Mr. Gunay Gungen 他
11 金	ホテル(公用車)訪問先	1。移動(アンカラから440 キロ) 2。特殊製鋼公社、製鋼工場	1。移動 2。挨拶・日程確認	Mr. Ali Zengil 他
12 土	ホテル(公用車)訪問先	1。特殊製鋼公社、製鋼工場	1。見学・質疑応答 2。セミナー	Mr. Yahiya Keskin他
13 日	ホテル(公用車)ホテル	1。アンカラへ移動		
14 月	ホテル(公用車)訪問先	1。日本大使館	1。報告書作成、2。報告	広瀬参事官他
15 火	ホテル(公用車)空港 アンカラ (TK111) イスタンブール 08:30 09:25 イスタンブール(TK814) カイロ 12:45 14:45 空港(タクシー)ホテル		1。出国、移動、到着	
16 水	ホテル(タクシー)訪問先	1。JICA事務所 1。デルタ製鋼所(カイロから約数十キロ)(Mostrod)	1。挨拶・日程確認 1。見学・質疑応答 2。セミナー	橋本所長他 Dr. Ezzat Abu Hassan他
17 木	ホテル(タクシー)訪問先	1。国立金属研究所、 1。エジプト製鉄所(カイロから約数十キロ) (Helwan)	1。挨拶 1。見学・質疑応答	Dr. Azim 他 Mr. Hassan Abdul 他
18 金	ホテル(タクシー)訪問先	(エジプト国休日) 帰国研修員宅訪問	1。質疑応答	Mr. Samir Ghali 他
19 土	ホテル(タクシー)訪問先	帰国研修員宅訪問	1。質疑応答 2。報告書作成	Mr. Hamed 他
20 日	ホテル(タクシー)訪問先	1。JICA事務所 1。日本大使館 1。工業省経済協力局	1。報告、2。挨拶、 1。報告、2。挨拶 1。報告、2。挨拶・質疑応答	橋本所長他 安村一等書記官 Mr. Sani 他
20 日	カイロ 23:35 (PK712) 14:00 カラチ	(途中ダーハン空港臨時着陸)	1。出国、移動	
21 月	カラチ着 14:00	ＴＥＬＥＸ 発信	1。到着	
22 火	カラチ 07:00 (PK770) 10:00 コロンボ 空港(タクシー)訪問先	1。JICA事務所 1。日本大使館	1。挨拶・日程確認 1。挨拶	橋口所長他 小林二等書記官
23 水	ホテル(タクシー)訪問先	1。セイロン製鋼公社(コロンボから約10数キロ) 1。外務局	1。見学・質疑応答 1。挨拶・質疑応答	Mr. Pereira 他 Mrs. Amerasekera 他
24 木	ホテル(タクシー)訪問先	1。地方政府住宅建設局 1。帰国研修員宅訪問	1。挨拶・質疑応答	Mr. Abeyaratne 他 Mr. Harriman A. 他
25 金	ホテル(タクシー)訪問先	1。セミナー会場(JICA事務所内) 1。セイロン金属工業公社(約10数キロ)	1。セミナー実施2。懇親会 1。見学・質疑応答	Mr. Banda S. 他 Mr. Semasinghe 他
26 土	ホテル(タクシー)訪問先	1。JICA事務所 2。帰国研修員宅訪問(同窓会副会長)	1。報告書作成 2。報告	Mrs. Porage 他
27 日	コロンボ (SR188) シンガポール 09:25 15:45	1。移動	1。出国、移動、	
28 月	シンガポール(JL710) 東京 22:15 06:10 東京 (ＪＮＲ) 名古屋	1。移動(帰国) 2。事業団本部 1。移動	1。移動、到着 2。帰国手続、挨拶、 1。移動	宮本所長他

5. 会見者記録（トルコ）（訪問順）

◎印は本コース、○印は他コースの帰国研修員

1. 日本大使館

   Councelor, Mr. Tetsuya Hirose

   Attache, Mr. Takahiko Katsumoto

   L. Officer, Mr. Barlos Gökova

   JICA Expert, Mr. Hiroshi Kambara

2. State Planning Organization

   ○ Overseas Training, Mrs. Meral Orgun （技術協力セミナー）

   Steel I. Expert, Mr. Engin Oruç

3. Turkish Iron & Steel Works

   Vice Manager, Mr. A. Kalaycioglu

   ◎ Chief Eng., Mr. B. Dinçel （本コース）

   Manager F., Mr. Hassan Tuna

   ○ E. Production P, Mr. Mustafa Bayat （熱処理コース）

   Manager, Steel, Mr. Coskun Aktel

   Chief, Steel, Mr. Seref Yüsebag

   Engineer, Mr. Ahmet Bal

   Engineer, Mr. Necip Ebegil

   " Mr. M. Doruk

   " Mr. Refik Kandarli

4. Asil Çelik

   General Director, Mr. Yahya Keskin

   Plant Manager, Mr. Ali Zengil

   Manager, Steel M., Mr. Ö. Yelmaz

   Manager, Rolling, Mr. Y. Saatçi

   Manager, Metallurgy, Mr. Engun Onur

   Chief, Melting, Mr. Akif T.

   Engineer, Mr. Adnan Günes

   ◎ Chief, Ref. P. Mr. Levent Pekuysal （1984、本コース）

5. MKEK

   Director, Mr. Burlan Ersan

   ○ Asst. Director, Mr. Sinan Kalyoncu （1975、鋳造）

   ○ " Mr. Orhan Buyakay （1984、金属加工）

   ○ Q. C. Manager, Mr. Hikmet Tekmen （1983、金属加工）

○ Production Head, Mr. Mustafa Ogüz (1979、金属加工)

○ Planning Manager, Mr. Gengiz Karaka (1978、建設機械)

○ Engineer, Mr. Sengiz Seryen (1982、溶接)

6. その他

○ Mr. Ahmet Ozalp, President, MITA (1977、金属加工)

○ Mrs. Sabiha Ozalp, MITA (1975、金属表面処理)

○ Mr. Mustafa Ozden, Director, Eltem (1971、鋳造)

Mr. Ismet Unan, President, UNSAN

備考：本コース帰国研修員5名中下記3名は会員不可。

1. Mr. I. Hakki Gurol (1976参加)
   退職し、製鋼用スクラップ業経営(イスタンブール)
2. Mr. Nuri Ozdemiel (1977参加)
   退職し、鋳造工場長(民間、ブルサ)
3. Miss Nihal Tumar (1979参加)
   結婚し退職

会見者記録(エジプト)訪問順

1. JICA カイロ事務所

Director, Mr. Akihiko Hashimoto

Staff Mr. Shozo Matsuura

Local staff, Mr. Moheb C. Ghali

2. デルタ製鋼所

Chairman, Mr. Moheb Tadros Ghali

General Manager, Mr. Hassan Fayed

General Manager of Steel Making, Mr. Mohamed Harras

General Manager, Q. C., Dr. M. Shaker Shalaby

Continuos C. Manager, Mr. Khairy Husoein

Technical Director, Mr. Mohsin Zaki

◎ Chief of Production, C. C., Mr. Mohd. Ahmed Abd El Latif (1978、本コース)

Chref of 18 Ton F'ce, Mr. Abdel B. Younis Ahmed

Chief of 12 Ton F'ce, Mrs. R. M. Tawadrous

Chief of Production, Mr. Hussein A. Abu Zarra

Chief of Production, Mr. Salah El Din Ahmed

◎ Chief of New Steel Making, Mr. G. Ahmed Radwan (1981、本コース)

Engineer, Mr. Hamed Abd. Eliazik

" Mr. Mustaffa M. Solah

Engineer, Mr. Mohamed S. Auel

3. 国立金属研究所

General Metallurgical Research = Development Institute

Director, Dr. A. A. Abdul Azim

○ Researcher, Mr. Sayed F. Moustafa (1983、鋳造)

JICA専門家, Mr. Fumito Yoshino

Sun Rise Co. Staff, Mr. Salah Mansy

4. General Manager, Physical Planning,

○ General Organization for Physical Planning (GOPP)

Mr. Samir Ghaly (1962、都市計画)

5. エジプト製鉄所

Chief, Steel Sector, Mr. Hassan Abdul Arif

General Manager, Training, Mr. Abdul Faltah Metureley

Chief, Managerial Section, Mr. Abdul Aziz Badawy

Chief, Abroad Mission, Mr. Emeil Aziz

◎ Manager, Arc F'ce Melting, Mr. Hamed Ahmed Al El Fadle (1978、本コース)

◎ Manager, Continusus Casting, Mr. Ahmed El S. A. El Ghany Kandel (1982、本コース)

◎ Manager, Scrap = Maferials, Mr. Arafa Hassan Tawfik (1980、本コース)

6. 日本大使館

Mr. Hironobu Yasumura)1st Secretaryº

7. Ministry of Industry, Under Secretary for Foreign Relation

○ Mr. Samy Darwish (経済協力セミナー)

備考:本コース帰国研修員8名中

Mr. Yahia El Ridi Abbas (1977) (石油公社へ転職)

Mr. Isaac Jacob Morkus (1979) (病欠)

Mr. Sherif Sobby Mikel (1983) (米国で研修中)

上記3名は会見できなかったが、他の5名には会見することができた。

会見者記録(スリランカ)訪問順

1. JICA コロンボ事務所

Director, Mr. Jiro Hashiguchi

Staff, Mr. Minora Sasago

Local Staff, Mr. L. W. B. D' Olivera

2. 日本大使館

Second Secretary, Mr. Masahiro Kobayashi

3. セイロン製鋼所

○ General Manager, Mr. Michal Pereira （鉄鋼コース、東京）

○ Manager, I. E., Mr. Kosala A. J. （1979、金属加工）

◎ Manager, Foundry, Mr. J. M. Ranasinge B. （1977、本コース）

◎ Asst. Manager, Foundry, Mr. A. P. H. Perera （1978、本コース）

○ Manager, Lab., Mr. C. Chamley A. Silva （1981、本コース）

○ Asst. Lab., Miss Sumana W. Y. （1983、熱処理）

◎ Metalluragist, Mr. D. B. Siviwardane （1982、本コース）

◎ Engineer, Mr. Palpagama （1983、本コース）

3. Dept. of External Resources

Deputy Director, Mrs. C. Amerasekera

4. Ministry, Local Government Housing & Construction

Acting Secretary, Mr. R. Abeyaratne

○ Deputy Director, Mr. D. Weerapana （1984、国連地域開発）

5. セイロン金属工業公社

○ Works Manager, Mr. L. B. Semasinghe （1982、鉄鋼検査）

◎ Engineer, Production Planning & Sales, Mr. J. J. K. Silva （1984、本コース）

6. JICA スリランカ同窓会副会長

○ Mrs. D. I. Porage （1968、中小工業セミナー）

青少年対策雇用促進局長

7. ○ Mr. Harriman A. （1985、中小工業セミナー）

備考：

本コース帰国研修員8名中

Mr. W. A. S. Sunanda De Silva (1976)

Mr. A. P. H. Perera (1978)

以上退職

Mr. Wilson Ratnayake (1980)

休職（病欠）

3名は上記の理由で会見できなかったが、他の5名に会見した。

6. 調査項目、方法

調査の方法として英文Ouestionaire（別添）を事前に現地へ送付し回答を得る方法と現地で面談等による方法が採られ、その項目は以下のとおりである。

1) 窓口機関に対して（Ouestionaire A）

応募者指名に至る迄の公式ルート及びそれに要する日数、応募者選考（現地側）の難易度、選考基準、GI記載事項の明瞭度及びGI送付のタイミング、本コースの評価及び今後について等が実施された。

2) 研修員所属機関に対して（Ouestionaire B）

各国における製鋼事情は可成りのレベル差があると思われ、本コースの研修カリキュラムの編成、運営等に大きな影響を与える因子を多分に有している関係上、本件には可成りのウエイトが置かれた。本コースの特徴である電気炉による製鋼技術の観点から、

① 生産鋼種（材質） ② 電気炉及びトランス容量 ③ 電力消費原単位及び電力料金

④ 製鋼速度（H） ⑤ 酸素使用の有無或は消費量等 ⑥ 製鋼用耐火物

⑦ 世界的（途上国を含めた）傾向である連続鋳造の有無或は計画等今後本コース関係者のよき参考となるべく調査が実施された。

3) 帰国研修員に対して（Ouestionaire C）

本コースに対する評価（研修内容、レベル等）及び帰国後、習得技術、知識の活用度、本コースへの提言等について実施された。

7. 指導内容・方法

本コースの主要テーマである電気炉による製鋼技術は、

1) 炉及びトランス容量の増大 2) 酸素吹込法の導入 3) 水冷パネルの導入

4) 真空脱ガス法の導入 5) LF及びVSCの導入、浸せきノズルによる連鋳技術の向上等々による操業時間の大巾短縮、電力原単位の低減、品質の向上等技術革新には著しいものがある。

本巡回指導班は過去30年間わが国における、その技術進歩の全容及び近年或は将来の方向等について、現地でのセミナーと質疑応答、各国での工場見学と質疑応答を実施した。

以下、各国別に調査内容、指導内容、ニーズへの対応等につき報告いたします。

8. トルコ共和国

8－1　窓口機関（Ouestionaire A）について（10月9日）

State Planning Organization, Social Planning Bureau の技術協力担当官

Mrs. Meral Orguro 及び鉄鋼担当官Mr. Engin Oruc に会見

質問状は1ケ月前に発信されたが、相手国内の手続きに時間を要し、回答書状の入手は不可であった。この点につき、当国は約2ケ月を要するとの事である（日本大使館）、但し、GIについては現状で問題なく、本年度も例年通り応募締切前にNITCへ到着している。応募者の選考（現地側）については過去の事例にても判断できるように帰国研修員全員（5名）が（国営製鉄所（4名）、特殊製鋼公社（1名））製造工場の技術者、担当者であり、当国での応募者の選考は適格でありGIの内容はよく把握されており、また本コースGIの内容は理解し易い旨の評を得た。トルコ共和国は鉄鋼生産を可成り重視しておるので今後も研修員受入れ等協力方要請された。

8－2　研修員所属機関について（Orestionaire B）

本件については、質問の量及び技術的なことと、当国は第1訪問国である点等を考慮しJICA本部了承の上直接訪問先の工場長宛、即ちトルコ製鉄カラブク工場長、Mr. Ata Poyraz 氏及び特殊製鋼公社工場長 Mr. Ali Zenzil 氏へ送付され、所期の成果が得られた。

当国においては、一行が訪問する工場は夫々別々の遠隔に立地されている関係上、セミナーを各工場において実施した。以下、トルコ共和国における製鋼事情、訪問工場の実情、帰国研修員の活動状況、問題点、本コースへの対応等順次報告いたします。

8－3　トルコ共和国製鋼事情

人　口	46,5百万人		
GNP	690ドル	(1982)	JICA
帰国研修員	1,417人	(1984)	JICA
	87人	(1984)	NITC
	42人	(1984)	〃　（金属関係）
鉄鋼生産量	454.5万トン	(1984)	
同上世界	平均1人当り年間生産量157 Kg		
同上日本	同　上　913 Kg		
同上トルコ	同　上　98 Kg		

トルコ共和国における1984年現在の鉄鋼生産の内訳は下記のとおりである。

Erdemir	1,575,000トン	(高炉転炉)
Ibdemir	900,000トン	(〃)
Karabuk	510,000トン	(高炉、平炉)
MKEK	160,000トン	(電気炉)
民間工場	1,400,000トン	(〃)

以上の現況の中で電気炉による生産量は

トルコ 45.5% 日本 27.7%

であり、トルコにおける鉄鋼生産量455万トンのうち、

普通炭素鋼	430万トン
合金鋼等(特殊鋼)	25万トン

当国の経済は可成り活発であり、鉄鋼増産計画が進められており1989年には、

Erdemir	2,200,000トン
Ibdemir	2,300,000トン
Karabuk	700,000トン
MKEK	300,000トン
民間工場	2,000,000トン
合計	7,500,000トン

が計画されており、現在の世界平均を上まわる。

尚、当国には下記の製鋼工場がある。

1. Karabuk Demir Celik
2. Iskendern Demir Celik
3. M.K.E.Kurum
4. Asil Celik
5. Cukurova Celik
6. Colakoglu Metalurji
7. Metas
8. Tuber
9. Icdas
10. Elektrofer
11. Kroman Celik
12. Arc Celik

13. Istanbul Metalurji
14. Cemtas
15. Kaliteri Celik
16. Demsan
17. Seldemir
18. Sensa
19. Izmir Demir Celik (projected plant)
20. Habas (〃)
21. Ekinciler (〃)

8－4 トルコ製鉄所カラブク工場

工場長 Mr. Ata Poyraz

従業員 11,339名うち（技術者300名）

施 設 高炉 3基

平炉 150トン炉6基（Tap－Tap 9.5H）

電気炉 18トン炉1基（Tap－Tap 5.5H、出鋼 1580℃ GS－52）

〃 3.5トン炉1基

誘導炉 1トン炉1基、5トン炉1基

るつぼ炉 1トン炉3基、0.5トン炉2基

粗 鋼 510,000トン／年（50万t～60万t）

鋳 鋼 7,000トン／年（生産、CO_2、フラン）

鋳 鉄 40,000トン／年（ 〃 ）

非 鉄 500トン／年（ 〃 ）

備考：自国発生スクラップを使用、Fe－Crを除く合金鉄は輸入

アーク炉 18トン、6,700 KVA、2,690 mmø

〃 3.5トン、1,500 KVA、1,920 mmø

電力原単位 750 KWH／トン

電極、輸入（日本、ヨーロッパ）（14インチø、8インチø）

電極原単位 7 Kg／トン

耐火物（国産）

寿命 天井 45 heats

炉壁 60 〃

炉床 60 〃

誘導炉　5トン炉　50Hz

1トン炉　150 Hz（3倍周波）

インゴットケース（自工場製）原単位20Kg／トン

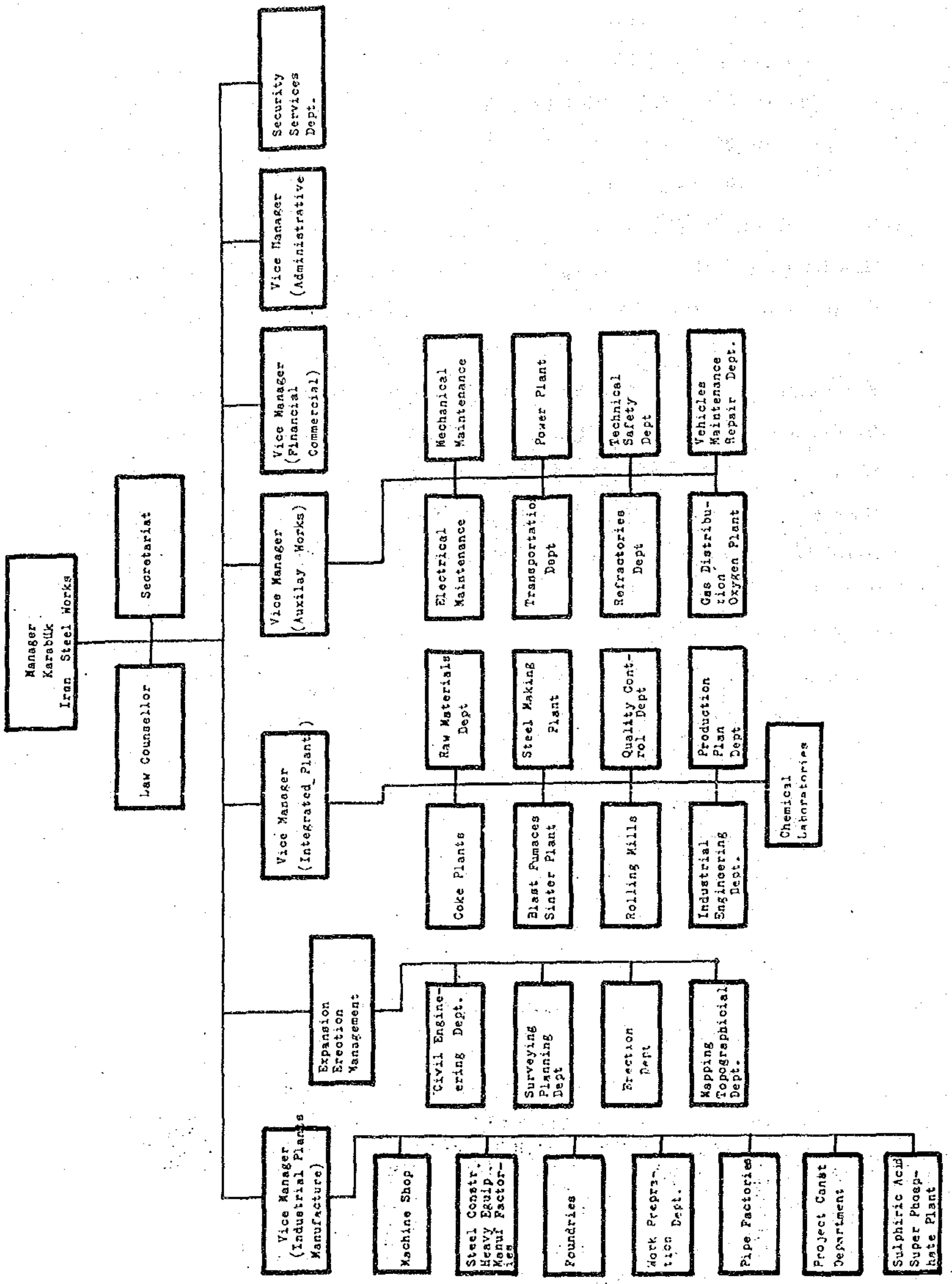
材　質　C 3.5～4.5　Si 1.52～2.30

Mr 0.6～1.2　P 0.10 Max

S 0.10 Max（木型はシナの木を使用）

カラブク工場技術者内訳（300名）

Machine Shop	12	Rolling M	10	Steel Const	11	Q.C.	4
Project Const	11	Chem. Lab	16	Foundries	11	I.E.	7
Work Prep	2	Prod. Plan	2	Pipe Factory	2	Raw Mat	12
Sul Acids	5	Electrical M	13	Planning	16	Mach. M.	11
Erection	23	Transport	6	Exp.Erect	24	Power P.	8
Civil E.	20	Refractories	5	Map & Top	4	Gas. Oxy P.	5
Coke P.	11	Tech.Safety	3	Blast F	10	Vehicle M	4
Steel M.	8	Others	16				



Manager
Karabük
Iron Steel Works
Secretariat
Law Counsellor
Security Services Dept.
Vice Manager (Administrative
Vice Manager (Financial Commercial)
Vice Manager (Auxilay Works)
Mechanical Maintenance
Electrical Maintenance
Power Plant
Transportation Dept
Technical Safety Dept
Refractories Dept
Vehicles Maintenance Repair Dept.
Gas Distribution Oxygen Plant
Vice Manager (Integrated Plant)
Raw Materials Dept
Coke Plants
Steel Making Plant
Blast Furnaces Sinter Plant
Quality Control Dept
Rolling Mills
Production Plan Dept
Industrial Engineering Dept.
Chemical Laboratories
Expansion Erection Management
Civil Engineering Dept.
Surveying Planning Dept
Erection Dept
Mapping Topographicial Dept.
Vice Manager (Industrial Plants Manufacture)
Machine Shop
Steel Constr. Heavy Equip. Manuf Factories
Foundries
Work Preparation Dept.
Pipe Factories
Project Const Department
Sulphiric Acid Super Phosphate Plant

8－5　トルコ製鉄所カラブク工場評

イ）本工場はアラカンから 200 有余キロの山中に所在し、原材料は国鉄により、製品はトラックにより夫々輸送されている。石炭が近くにある以外に立地のメリットは考え難く、国防上の理由から設立された。

上述工場概要にあるように高炉→平炉→上注ぎ方式で４０年位或はそれ以上過去へタイムスリップした感がある。平炉操業時間（Tap－Tap）が９時間半で非常に長く、酸素吹込等により時間短縮を提案したが現在点で造魂、圧延等バランスがとれているので簡単に指導はできない。

当国においては、他工場にて近代化、増産化が図られているので当工場はむしろ、大型鋳鍛造、機械加工の方向へ進むべきと思われる。

ロ）帰国研修員について

会見者記録で述べたように本製鉄所から４名研修を受けた。うち１名（女性）Miss Nihal は他の工場にて転炉担当（中東工科大学冶金枠）であったが結婚退職、Mr. Curol は当カラグク工場を退職、イスタンブールにて製鋼用スクラップ供給業を自営、Mr. Nuri は当工場を退職ブラサにて鋳鋼工場長として在職、Mr. Bulent は現在も当工場（鋳造本部技術部長）にて造魂用インゴットケース、鋳鋼等の技術管理に活躍中であり、鋳造技術に関しては途上国の中で上位にランクされる。当工場帰国研修員は全員鋳造本部から参加した者であるが１８トン電気炉を有しているので窓口機関の応募者選定は理解できる。むしろ、平炉担当者が応募した場合、わが国にては研修不能であり、また本コースの主旨に反すると思われ、今後当工場からの応募は鋳造コースには向くが本コースには不向きである。

尚、帰国研修員Mr. Bulent からの本コースに対しインゴットケースの製造技術を考慮すべきとの意見が提案され、この点については総括の項で報告します。

8－6　特殊製鋼公社（本社イスタンブール、工場オーハンガジ）

理事長　　Mr. Yahiya Keskin（別紙組織図参照）

従業員　　149 名

施　設

電気炉　　４５トン炉１基（日本ＩＨＩ納）24,000 KVA　5,000 ㎜ø（炉径）

同　上　　１５トン炉１基（日本ＩＨＩ納）11,000 KVA　3,000 ㎜ø（炉径）

（ＲＨ脱ガス設備、２ベッセル米国レクトロメルト納）

電力原単位　500 KWH／トン

電極、輸入（ユニオン、カーバイト）

電極　１８インチø　原単位　4.5 Kg／トン

酸素吹込圧　１２㎏／㎠　原単位　２８㎏／トン

ランスパイプ（自国製）

耐火物　炉壁　350 heats（国産）

炉床　3,000 he〃　（〃）

天井　220　〃　（８０～８５％Al_2O_3）輸入

当社 1974 設立、民間であったが１年前から State Owned となった。

Tap to Tap　2H

Tapping Temp　例 1680 ℃

スクラップ　７０％輸入

Fe−Si　５０％ 〃

Fe−Cr　国産

その他合金鉄：輸入

インゴットケース（国産）

原単位　１７㎏／トン（７０回）

材　質　C. 3.08 Si 1.30

mr 0.80 P 0.05

S 0.03 max

当工場生産量及び鋼種

特殊鋼　140,000 トン／年（全量下注造魂）

材　質（後述表参照）

スクラップ　５０～６０TL／㎏

電力料金　３３TL／㎾（夜間半額）

別　添

GRADES OF STEEL

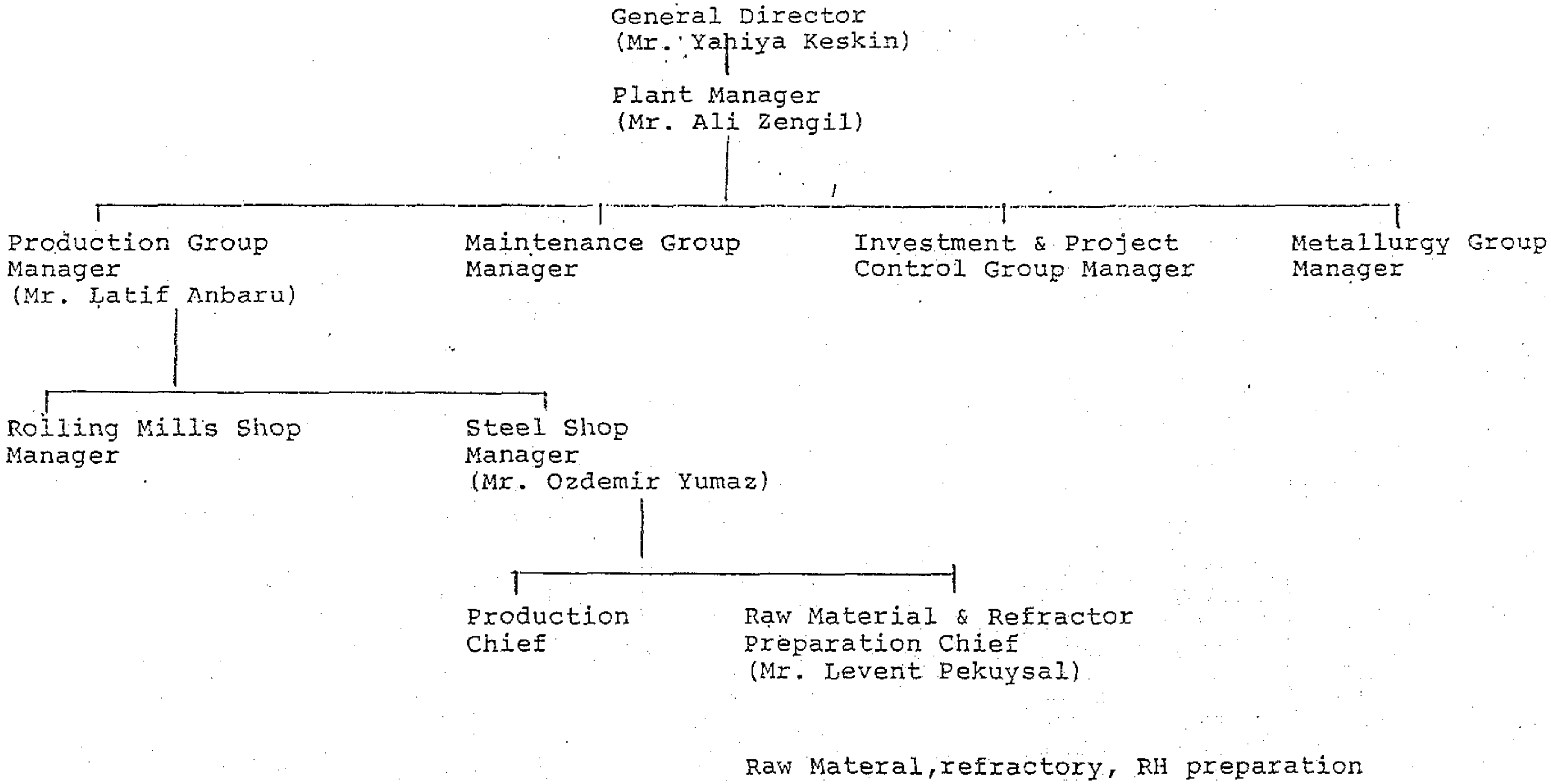
TYPE OF STEEL	DIN NORM Material No	DIN NORM Symbol	Corresponding SAE or AISI STANDARD
Structural Steels	1.0401	C15	1015
	1.0402	C22	1020
	1.0501	C35	1035
	1.0503	C45	1045
	1.0601	C60	1060
Free Cutting Steels	1.0715	9SMn28	1113
	1.0718	9SMnPb28	
	1.0721	10S20	1115
Spring Steels	1.0904	55Si7	9255
	1.0906	65Si7	
	1.0908	60SiMn5	
	1.0909	60Si7	9260
	1.0961	60SiCr7	9262
Constructional Steels	1.1141	Ck15	1015
	1.1151	Ck22	1020
	1.1172	Cq35	1030
	1.1181	Ck35	1035
	1.1186	Ck40	1040
	1.1191	Ck45	1045
	1.1192	Cq45	
	1.1210	Ck53	1050
	1.1213	Cf53	
	1.1221	Ck60	1060

TYPE OF STEEL	DIN NORM Material No.	DIN NORM Symbol	Corresponding SAE or AISI STANDARD
Constructional Steels	1.5527	40MnB4	
	1.5590	30MnB4	
	1.5592	30MnB4Cr	
	1.5710	36NiCr6	3130
	1.5713	13NiCr6	3120
	1.5752	14NiCr14	3310
	1.6511	36CrNiMo4	9840
	1.6523	21NiCrMo2	8620
	1.6543	21NiCrMo22	8720
	1.6546	40NiCrMo22	8640
	1.6582	34CrNiMo6	
	1.7033	34Cr4	
	1.7034	37Cr4	5135
	1.7035	41Cr4	5140
	1.7103	67SiCr5	
	1.7131	16MnCr5	5115
	1.7147	20MnCr5	5120
	1.7218	25CrMo4	
	1.7220	34CrMo4	4130
	1.7225	42CrMo4	4140
	1.7228	50CrMo4	4150
	1.8159	50CrV4	6150
	1.8161	58CrV4	
Ball Bearing Steels	1.3505	100Cr6	52100
Tool Steels	1.1540	C100W1	W2
	1.1740	C60W3	W1
	1.2080	X210Cr12	D3
	1.2208	31CrV3	
	1.2344	X40CrMoV51	H13
	1.2365	X32CrMoV33	H10
	1.2550	60WCrV7	S1
	1.2601	X165CrMoV12	D2
	2714	56NiCrMoV7	L6
	1.2842	90MnCrV8	02

The above table gives an outline of steel grades produced by ASİL ÇELİK under its standard programme. However, other steel qualities can also be delivered on request according to customer specifications.

Asil Celik A. S.

Gemic Koyu Mevkii
Orhangazi- Bursa



Melt Shop

15 t electric arc furnace x 1 unit
45 t " x 1 "
RH degassing unit x 1 "

Blooming & billet mill

Soaking pit furnace (40 t/hr) x 6 units
Pusher type furnace (40 t/hr) x 1 "
Blooming mill(820 mm two-high reversible mill, 40 t/hr)x 1 unit
Hot scarfing unit x 1 unit
Billet mill(750 mm two-high reversible mill, 40 t/hr)
Cooling bed

Medium section mill

Walking beam furnace (20 t/hr)
Medium section mill

4 stand mill: the 1st 3 stand being three-high
the 4th stand vertical two-high 550 mm
1 finishing stand two-high, 420 mm 20 t/hr

Cooling bed

Conditioning & Q.C. department

1 roller hearth heat treating furnace (20 t/hr)
Physical, metallography & chemical laboratory
Shot-blasting, straightening, grinding, cutting equipments
Magno-flux, eddy current, ultasonic testing equipments

Utilities & maintenance department

Fuel oil, LPG, Oxygen, Argon, & water supply system
Compressed air, steam, power generator
Dust collector
Mechanical, Electrical, Electronical & Instrumental Workshops

8－7　特殊製鋼公社評

理事長Mr．Yahiya Keskin は機械化学工業公社（MKEK）キリカレ製鋼所（電気炉により特殊鋼等生産）の製鋼本部長であったか1974 年当社（民間）に参加当社は1年前に国営企業となった。

工場概況で理解できるように当工場は日本の設備（IHI納）であり、また約1年前にトピー工業㈱豊橋製造所から技術者が派遣され数ケ月間指導を行ったこともあり、可成りのレベルに達して（途上国として）いる。LF．CC等更に設備近代化を希望している為か指導よりもセミナー及びその内容等について（新しい技術）工場長以下8名、当日（土曜日）管理職、技術者等休日であったが、熱心な質問が集中した。帰国研修員Mr．Levent は本年6月に帰国、本コースに全て満足、コメントなしである。

8 — 8

SUMMARY REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA EX-PARTICIPANTS IN ELECTRICAL STEEL MAKING ENGINEERING COURSE

1. Introduction

Being dispatched by the Japan International Cooperation Agency as part of its technical follow-up pragramme for the ex-participants in the electrical steel making engineering course, the team, consisting of three members headed by Mr. Jutaro Shimogo, Acting General Manager of Daido Steel Co., Ltd., arrived in Ankara on the 8th of October, 1985 and conducted its follow-up activities for a period of 8 days.

The team has the pleasure to submit a summary report on the results of its study for the purpose of reference by the officials and engineers of the authorities concerned in the Government of Turkey.

2. Team Members

(1) Team Leader & Technical Advisor:	Mr. Jutaro Shimogo Acting General Manager, Overseas Technical Cooperation Dept., Daido Steel Co., Ltd.
(2) Technical Advisor:	Mr. Ryuzo Komatsu Engineer, Continuous Casting Dept, Aichi Steel Works, Ltd.
(3) Coordinator:	Mr. Kaniji Takeuchi Training Officer, Nagoya International Training Centre, JICA

3. Objectives

The dispatch of the team is primarily aimed at reviewing, assessing and evaluating the fruits of the training in Japan by visiting the organizations to which the ex-participants belong, as well as through personal interviews with ex-participants and their superiors.

The second aim of the team is to have a technical discussion meeting in order to find out the needs, effectiveness and evaluations of the training programme, and to make further improvements for the training course.

4. Summary of the Follow-up Activities & the General Impression

We conducted;

- interviews with responsible officials of the government organization for selection of participants-nominating department,
- interviews with managers of two participants-sending organizations,
- interview with ex-participants,
- seminar with ex-partcipants and their superiors and responsible steel making engineers & staffs in the steel plants.

Out of our discussions in the above, we could confirm the following points, including requests and opinions concerning the training programme in Japan for its implementation from now onwards in years to come:

(1) The concerned personnel interviewed highly evaluate the results of the training in Japan, expecting at the same time the possible further improvements of the training.

(2) Major reasons for high evaluation of the training pragramme are:

a) many Japanese steel plants, big & small, are included in the curriculum

b) related industries such as electrode & submaterials making are included in the curriculum.

(3) Basic policy of candidate participant' selection in Turkey has been to nominate:

a) high level engineers of wide experiences in the field of steel making(electrical),

b) such personnel in the position able to give multiplier effect to other people in the plant and/or country

We consider the applicants selection has properly been done and we quite agree with the above basic policy.

(4) Ex-participants are kept in high consideration for their reports and activities in the plants from their sending organizations.

(5) The organization selecting participants-nominating department confirms that the follow-up team' activities of this time is significant.

(6) All the ex-participants we interviewed note that they have tried their best for the application of knowledge and techniques obtained through the training for the betterment of steel making in their plants.

(7) All the ex-participants like to get technical information and also re-training if possible.

(8) Steel making in Turkey is great among the developing countries in the fields of not only plain carbon but also alloy steels and their near future production will exceed the world average standard.

Finally, the Team would like to express sincere appreciation and gratitude to the kindness and cooperation of SPO, TISW(especially Karabuk Plant), Asil Celik, and the Embassy of Japan.

The 14th of October, 1985

J. Shimogo

Jutaro Shimogo
The Leader, the Follow-up Team
for JICA Ex-participants of the
Electrical Steel Making Engineering Course

List of Persons met with The Team

1- Embassy of Japon

Conncelor, Mr. Tetsuya Hirose
Liason officer, Mr. Barlas GÖKOVA
Affache, Mr. Takahiko Katsumoto

Experte from Japan (Mineral Resonce Surcey)
Mr. Hiroshi Kanbara

2- State PlanningOrganization
Social Planning Bureau
Mrs. Meral ORGUN
Mr. Engin ORUÇ

3- MKEK Machine Ind. Establishment

Director Burhan ERSEN
Asst. Dir. Sinan KALYONCU
Asst. Dir. Orhan BÜYÜKBAY
Q.C. Manager Hikmet TEKMEN
Production Head Eng. Mustafa OĞUZ
Planning Manager Cengiz KARACA

4- Turkish Iron And Steel Works KARABÜK Factory

Mr. Abdullah KALAYCIOĞLU (Vice Manager)
Mr. Hasan TUNA (Manager, Foundry)
Mr. Bülent DİNÇEL (Chief Eng. Foundry Nouferrous) 1980 E
Mr. Mustafa BAYAT (Eng. Foundry Production Planning Control) 1982 H
Mr. Ahmet BAL (Eng. Foundry, Cast Iroy)
Mr. Necip EBEGİL (Eng. Foundry Arc and Induction Furnaces)
Mr. Muharrem DORUK (Eng, Foundry Steel Castings)
Mr. Coşkun AKTEL (Manager, Steelmaking Shop)
Mr. Şeref YÜCEBAĞ (Chief Eng, Steelmaking Shop)
Mr. Refik CANDARLI (Eng, Steelmaking Shop)

5- ASİL ÇELİK

General Director, Mr. Yahya KESKİN
Plant Manager, Mr. Ali ZENGİL
Manager, Steel Making, Mr. Özdemir YILMAZ
Manager, Rolling Mill, Mr. Yavuz SAATÇİ
Manager, Metallurgi Dept. Mr. Ergun ONUR
Melf Shop Chief, Mr. Akif TUNABOYLU
Engineer, Mr, Adnan GÜNEŞ.
Chief, Refractory Preparation, Mr. Levent PEKUYSAL (1984 E)

6- Mr. Ahmet ÖZALP MİTA (1977 MW)
Mrs. Sabiha ÖZALP (1975)
Mr. Mustafa ÖZDEN Director ELTEM (F)
Mr. İsmet UNAN President, UNSAN

9. エジプト・アラブ共和国

9－1　窓口機関（１０月２０日訪問）

カイロ事務所、橋本所長同行の上、当国工業省経済協力局次長Mr . Samy Darwishに会見、質問状は約１ケ月前に発信されたが、相手国内の諸事情により時間を要し回答書状の入手不可。ＪＩＣＡ事務所設立後はアクションが早くなった（Mr . Samy ）が１ケ月以上要する様である。

この点につき、一行が訪問した工場のデルタ製鋼所は訪問当日に書類が届き、エジプト製鉄所は訪問前日に届いた状況であり、質問状の回収はＡ.Ｂ.Ｃ. 共に不可であったので当国の実情は筆談によるものである。

本コースのＧＩについては時期、内容等問題はなく応募者選考についても過去帰国研修員８名中エジプト製鉄５名、デルタ製鋼３名、全て現場技術者であり選考基準は適格である。また橋本所長は応募者全員に面接しておられその数は年間300名を超すと思われる。わが国の研修に対し応募者が一コースに複数の受入れを要望された。

本コースについて研修員受入れについては、上述の理由及び過去参加した研修員の全てレベルの高さ、本コースに対する熱心さ等問題は無いことを報告いたします。尚当国のニーズとして、第１に食品加工、第２に縫製技術であり機械金属はその後のグループに入る様である（Mr . Samy 氏）

9－2　研修員所属機関

質問状が訪問当日及び前日に到着した状態であったが、デルタ製鋼所Chairman, Mr .Ghaly他計１６名に対応して載き、また、エジプト製鉄所は当日管理職、技術者は休日にもかかわらず製鋼本部長Mr. Hassan他計７名が心よく対応して下さり感謝に絶えません。

以下当国製鋼事情等報告致します。

9－3　エジプト・アラブ共和国製鋼事情

人　口	44.3百万人	
ＧＮＰ	690ドル（1982）ＪＩＣＡ	
帰国研修員	1,417人（1984）〃	
	93人（1984）ＮＩＴＣ	
	31人（1984）〃	（金属関係）
鉄鋼生産量	150～180万トン	
同上　世界平均年間生産量		157 Kg／人
同上　日　本		913 Kg／人
同上　エジプト（150万トンとして）		34 Kg／人

エジプトアラブ共和国における鉄鋼生産量は約180万トンであるが、アレササンドリアにおいて直接製鋼法（日本の協力による）により1986年には300万トンが予定され1人当り68㎏となる。

9－4　デルタ製鋼所

総　裁　　Mr. Moheb Tadrous Haly（別紙組織図参照）

従業員　　4,000名

施　設

電気炉　　25トン炉2基（ソ）Tap－Tap 4H（700KWH／t）（10㎏／t）

〃　　18トン炉1基　12トン炉1基

〃　　3トン炉1基（伊）1500 KVA

〃　　2トン炉1基（伊）1500 KVA

誘導炉　　250㎏ 1基（伊）中性

〃　　1,000㎏ 2基（ソ）塩基性

〃　　1,500㎏ 2基（英）酸性

〃　　2,000㎏ 2基（西独）酸性

〃　　250㎏ 1基（米）酸性

月　産　　6,000トン　インゴット（普通鋼）

〃　　2,600トン　連鋳（2 Shift）（ソ）（15万トン／年、能力）コンキャスト

2.3～2.8 m／分　開放式鋳込

130㎜口、32～16㎜⌀、特殊5.5㎜⌀

当デルタ製鋼所の生産品目

棒　鋼（普通鋼）

線　材（　〃　）

各種鋳鋼（後述化学成分表参照）

球状黒鉛鋳鉄

高クロム鋳鉄

工具鋼（鋳鋼部門）

耐熱鋼（　〃　）

遠心鋳鉄管

インゴットケース（鋳鉄）

尚当国建設中のものとして

Evaco　　5,000トン／年（バルブ）ユーゴ

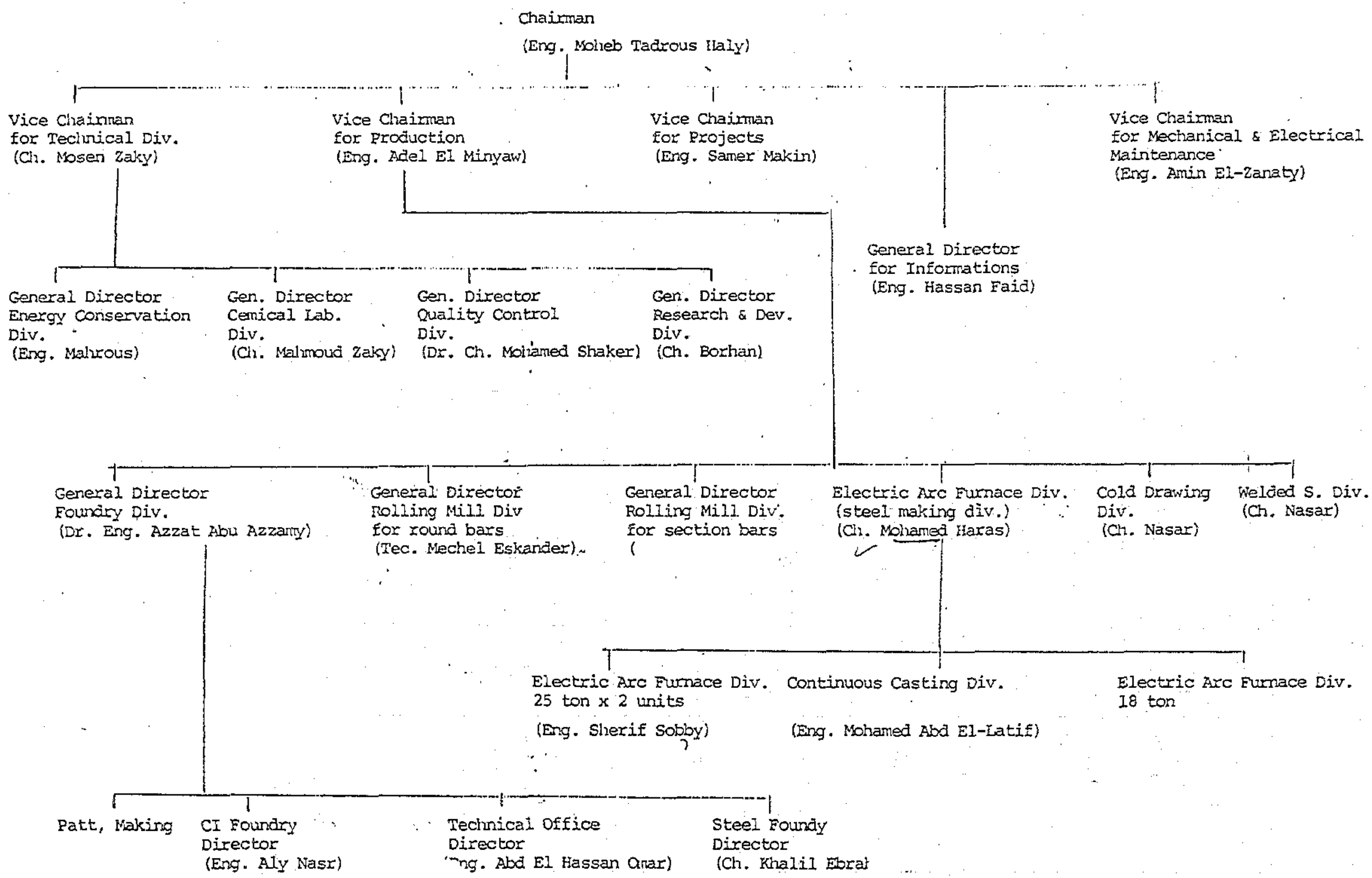
El－Giza　球状黒鉛鋳鉄（西独）

デルタ製鋼所における鋳鋼の化学成分と機械的性質

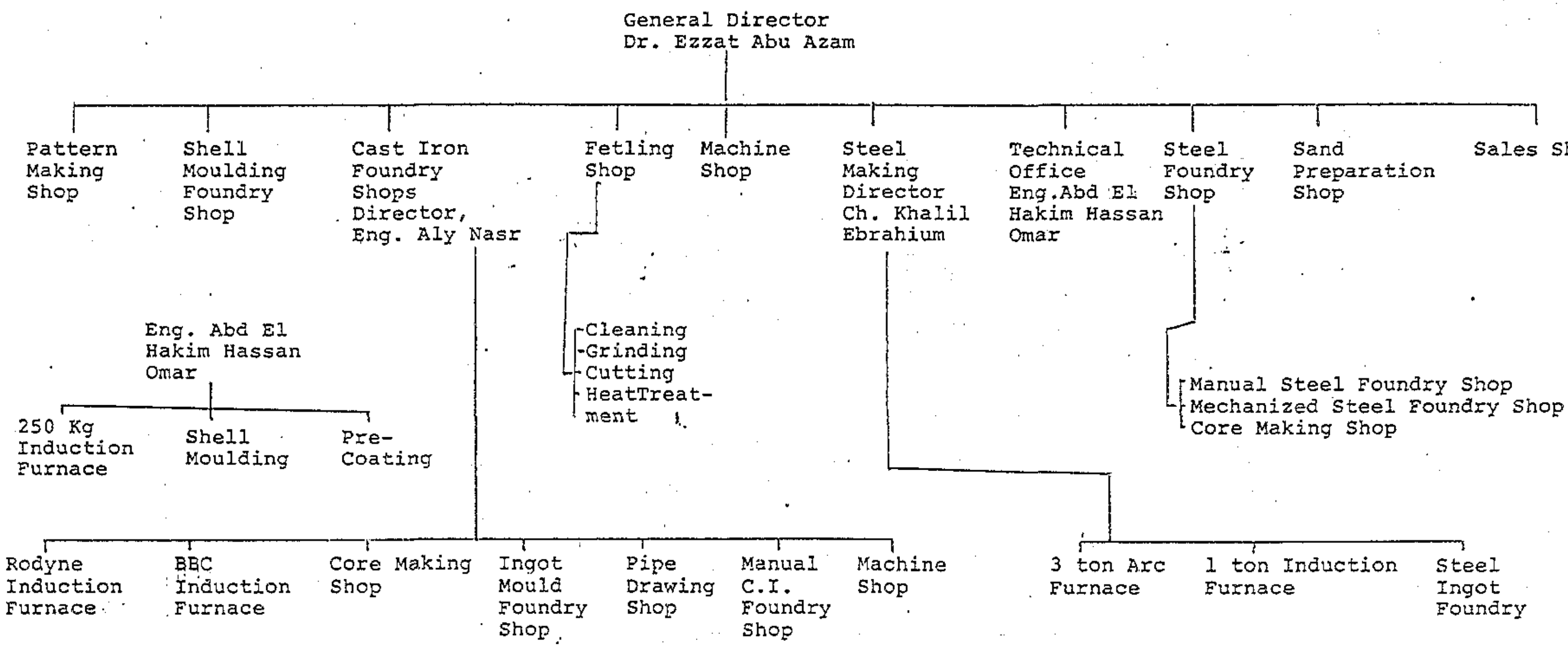
No.	C	Mn	S	P	Si	Cr	T.S. Kg/mm²	Y.S. %	Ductility %	HB
1	0.1 ～ 0.23	0.6 ～ 0.7	＜0.05	0.05	0.20～ 0.30		41	21	24	
2	0.22～ 0.27	0.5 ～ 0.7	＜0.05	0.05	0.20～ 0.35		40	20	20	
3	0.28～ 0.33	0.5 ～ 0.7	＜0.05	0.05	0.20～ 0.35		50	32	18	
4	0.35～ 0.40	0.6 ～ 0.8	＜0.05	0.05	0.20～ 0.35		60		14	
5	0.70～ 0.80	0.9 ～ 1.2	＜0.05	0.05	0.20～ 0.45		75		—	250
6	＜0.15	＜ 0.7	＜0.05	0.05	12 ～ 14		75		12	200
7	0.34～ 0.40	0.6 ～ 0.8	＜0.05	0.05	0.30～ 0.45	0.9 ～ 1.2	65		14	180
8	0.90～ 1.30	0.9 ～ 1.3	＜0.05	0.05	0.30～ 0.45	0.9 ～ 1.2	105		—	300
9	1.10～ 1.40	11 ～ 14	＜0.05	0.05	0.40～ 0.80				—	450
FCD	3.0 ～ 3.25	0.3	＜0.03	＜0.05	2.0 ～ 2.5	Mg 0.04	50 ～ 55			

Delta Steel Mill

Kalubia, Mostrod, Egypt



Delta Steel Mill Foundry



デルタ製鋼（伊）合併　5,000トン／年（セントボール）

などがある。

9－5　デルタ製鋼所評

イ)　本工場は、カイロから数十キロに立地し、上述のデータから理解できるように電気炉による製鋼法及び従来の造魂・圧延方式と6ヶ月前に稼動した電気炉、連鋳方式を採用、製鋼工場はソ連のものであるが最近の設備としては電らんの皮が一部とれていたり如何にも古い感がある。工場は雨が無いためか屋根を除き開放型であり砂漠砂の吹込等もあり雑然としている。連鋳が最近稼動したこともありセミナー後可成り質問がでた。

当工場の連鋳は浸せきノズルの使用なし、製鋼に於ては酸素使用等々品質にも問題がある。製鋼用耐火物（電気炉用、連鋳用）は輸入に依存している所も問題であるが、整理整頓からスタートすべきと思われる。尚、鋳造工場の方は上述データの通り各国の援助により各種の電気炉、誘導炉が夫々の容量で設置され、各種鋳鋼、高クロム鋳鉄、球状黒鉛鋳鉄等々を製造し、また、シェルモールド工場、遠心鋳鉄管工場をも有し、鋳物の一部は軍需用に使用されていることから判断して、そのレベルは可成り高いと思われるが残念ながら見学の時間がなかった。

ロ)　帰国研修員について

当所には帰国研修員3名（うち1名は現在米国にて研修中）いるが2名（会見者記録参照）に会見した。当工場の連鋳は6ヶ月前に稼動したがソ連製であるがソ連からの指導が余りなく苦慮している。日本での研修当時はわが国においても電炉メーカーの連鋳は未だの時であった関係で短期の再研修を強く希望された。

9－6　エジプト製鉄所

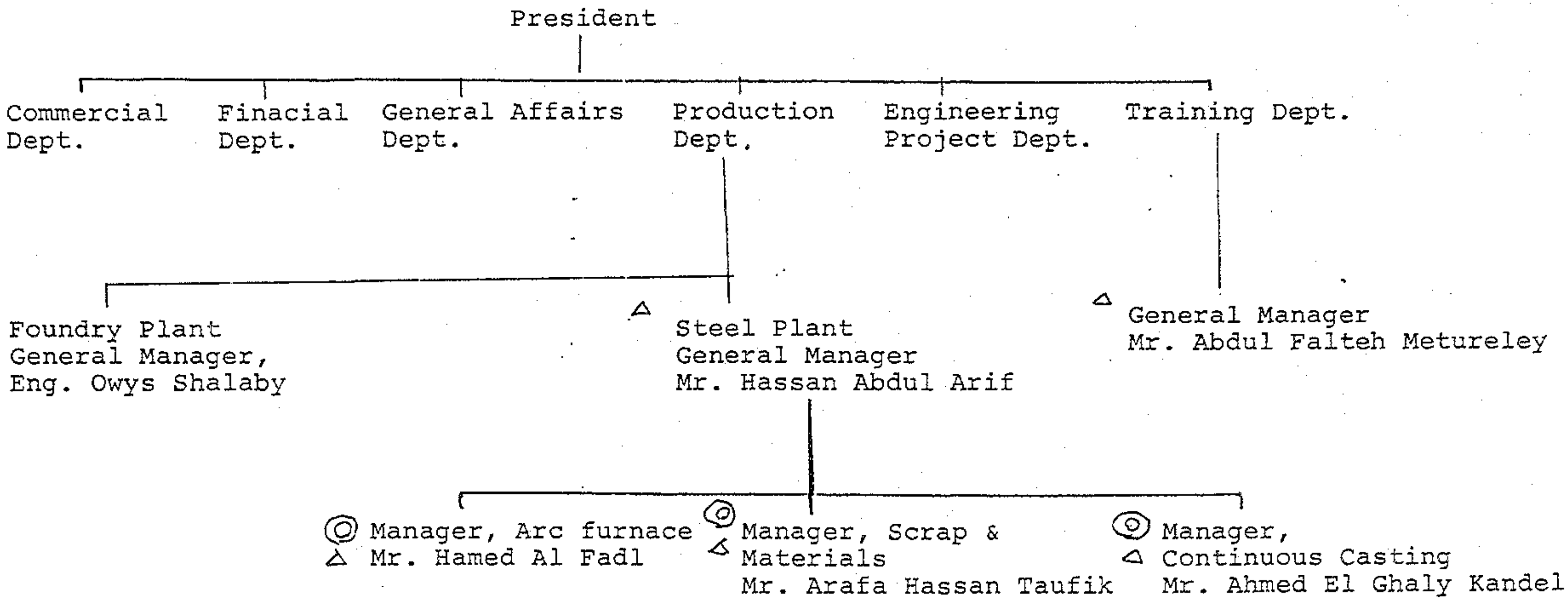
製鋼本部長　Mr. Hassan A.Arif（別紙組織図参照）

従業員　30,000名

施　設

焼結工場	2基	
高　炉	400トン／日1基	
〃	1,200トン／日1基	
トーマス転炉	17トン4基	
LD転炉	80トン3基	スクラップ250トン／日
電気炉	25トン2基	3,000～3,500トン／月（Tap－Tap＝2.5H）
〃	5トン1基	
連　鋳	400トン／日（スラブ）（1968設置）	

Egyptian Iron & Steel



△印　指導班会見者

◎印　本コース帰国研修員

（連鋳は高炉、転炉系統のもので約１０数年の経験を有し、開始時においては途上国の中でも最先端であったようである。）0.7ｍ／分鋳込床２２ｍH計器類全て故障の条件で鋳込

電気炉用鋼はビレット生産

スクラップ２５万トン在庫（推定）

９－７　エジプト製鉄所評

イ）当所はカイロから数十キロのHelwan地区に立地、一行は製鋼本部長Mr. Hassan他帰国研修員３名を含め計７名の休日出勤による応対を受け業務を実施した。

連鋳については機材設置（供与）側のフォローアップがほとんどなく開設当時からの進歩は全く見受けられなく、関連装置、計器類は作動せずの条件下で操業されている。わが国の常識にては想像を絶する状態であり、カンで連鋳可能な点は感心して了った。工場床面は凹凸でスクラップは八方散在方式であった。

本指導班に対して質問を自由に、沢山出して欲しい旨、再三問いかけて見たが、特に質問は考えてない旨の解答であった。

わが国の製鋼事情、世界の実情等の話の中で判明した事であるが、現在わが国の協力（ＮＫＫによる）アレキサンドリアの製鉄所El Dikheilaが稼動し1986年には当国の鉄鋼生産は大巾に増し300万トンに達する見込であり、当国の期待がかけられている。Helwanの工場の近代化は当分なく、逆に我々工場の経験者、技術者の多くがアレキサンドリアへ配転させられる気配が濃厚になってきたのでその方が目下の心配事である（本部長）。

ロ）帰国研修員５名中２名（１名転職、１名病欠）は、会見不可、他の３名に会見した。公式の場においては発言しないので夜間自宅訪問、談合の場を持ったが、①政治的理由等により日本での研修の成果を思う様に活用できないので本コースへの提言はない。②強い発言すれば、1）電気炉製鋼のための計算を各人に机上でやらせ、議論する。2）連鋳の所をしっかり（１日中）見ている、等がある。

9 — 8

SUMMARY REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA EX-PARTICIPANTS IN ELECTRICAL STEEL MAKING ENGINEERING COURSE

1. Introduction

Being dispatched by the Japan International Cooperation Agency as part of its technical follow-up programme for the ex-participants in the electrical steel making engineering course, the team, consisting of three members headed by Mr. Jutaro Shimogo, Acting General Manager of Daido Steel Co., Ltd., arrived in Cairo on the 15th of October, 1985 and conducted its follow-up activities for a period of 5 days.

The team has the pleasure to submit a summary report on the results of its study for the purpose of reference by the officials and engineers of the authorities concerned in the Government of Egypt.

2. Team Members

(1) Team Leader & Technical Advisor:	Mr. Jutaro Shimogo Acting General Manager, Overseas Technical Cooperation Dept., Daido Steel Co., Ltd.
(2) Technical Advisor:	Mr. Ryuzo Komatsu Engineer, Continuous Casting Dept., Aichi Steel Works, Ltd.
(3) Coordinator:	Mr. Kanji Takeuchi Training Officer, Nagoya International Training Centre, JICA

3. Objectives

The dispatch of the team is primarily aimed at reviewing, assessing and evaluating the fruits of the training in Japan by visiting the organizations to which the ex-participants belong, as well as through personal interviews with ex-participants and their superiors.

The second aim of the team is to have a technical discussion meeting in order to find out the needs, effectiveness and evaluations of the training programme, and to make further improvements for the training course.

4. Summary of the Follow-up Activities & the General Impression

We conducted;

- interviews with responsible officials of the government organization for selection of participants-nominating department,
- interviews with managers of two participants-sending organizations,
- interview with ex-participants,
- seminar with ex-partcipants and their superiors and responsible steel making engineers & staffs in the steel plants.

Out of our discussions in the above, we could confirm the following points, including requests and opinions concerning the training programme in Japan for its implementation from now onwards in years to come:

(1) The concerned personnel interviewed highly evaluate the results of the training in Japan, expecting at the same time the possible further improvements of the training.

(2) Major reasons for high evaluation of the training pragramme are:

a) many Japanese steel plants, big & small, are included in the curriculum

b) related industries such as electrode & submaterials making are included in the curriculum.

(2) Major reasons for high evaluation of the training programme are:

a) modern and conventional steel plants are included in the curriculum

b) Direct iron making process, continuous casting refractories for steel making, special refining process etc. are programmed

c) different types of steel making factories in Japan could be good reference to Egypt

(3) Basic policy of candidate participant' selection has been made in Egypt:

a) high class(level) engineers have been nominated

b) engineers nominated have been all the time from important steel plants in Egypt with well consideration of future expansion and quality & productivity improvement

c) such personnel in the position able to give multiplier effect to the people concerned

We consider that the applicant selection has properly and effectively done.

(4) Ex-participants are highly considered from their reports and activities after returning home country.

(5) The organization selecting participants-nominating department considers that the follow-up activities of this time are significant.

(6) All the ex-participants we interviewed have been trying their best for the application of the obtained knowledge and techniques for the improvement of steel making in the plants.

(7) All the participants we interviewed would like to obtain technical information about the steel making technology in Japan.

(8) Great emphasis has been put in Egypt for the development of steel industry and technical level in Egypt is high among the developing countires and the government development plan is also great.

Finally, the Team would like to express sincere appreciation and gratitude to the kindness and cooperation of the Government of Egypt, Delta Steel Mill, Mostrod, Egyptian Iron & Steel, Helwan, the related people of the steel industry in Egypt, and the Embassy of Japan and JICA Cairo Office.

The 20th of October, 1985.

J Shimogo

Jutaro Shimogo
The Leader, the Follow-up Team for JICA Ex-participants of the Electrical Steel Making Engineering Course

List of persons met the team(Egypt)

1. JICA Cairo Office

    Director, Mr. Akihiko Hashimoto
    Staff, Mr. Shozo Matsuura
    Local staff, Mr.

2. Delta Steel Mill

    Chirman, Mr. Moheb Tadros Ghali
    General Manager, Mr. Hassan Fayed
    Secretary, Madam Nani
    General Manager of Steel Making, Mr. Mohamed Harras
    General Manager, QC, Dr. M. Shaker Shalaby
    Continuous Casting Manager, Mr. Khairy Hussein
    Technical Director, Mr. Mohsin Zaki
    Chief, Continuous Casting, Mr. Mohd. Ahmed Abd El Latif
    Chief, 18 ton F'ce, Mr. Abdul B. Yunis Ahmed
    Chief, 12 ton Arc F'ce, Mr. R. M. Tawadros
    Chief of Production, Mr. Hussein A. Abu Zarra
    Chief of Production, Mr. Salah El Din Ahmed
    Chief of New Steel Making, Mr. G. Ahmed Radwan
    Engineer, Mr. Hamed Abd. Eliazik
    " Mr. Mustafa M. Slah
    " Mr. Mohamad S. Avel

3. General Metallurgical Research & Development Institute

    Director, Dr. A.A. Abdul Azim
    Researcher, Mr. Sayed F. Moustafa
    JICA Expert, Mr. Fumito Yoshino
    Staff, Sun Rise Co.,Mr. Salah Mansy

4. General Organization for Physical Planning

    General Manager, Physical Planning, Mr. Samir Ghaly

5. Egyptian Iron & Steel

    Chief, Steel Sector, Mr. Hassan Abdul Arif
    General Manager, Training, Mr. Abdul Faltah Metureley
    Chief, Managerial Section, Mr.
    Chief, Abroad Mission, Mr. Emeil Aziz
    Manager, Arc F'ce Melting, Mr. Hamed A. Al El Fadl
    Manager, Continuous Casting, Mr. A. E. S.A. El G. Kandel
    Manager, Scrap & materials, Mr. Arafa Hassan Tawfik

10　スリランカ民主社会主義共和国

10－1　窓口機関（10月23日）

外務局次長Mr．P．Amerasekeraに会見当国も他の2ケ国同様、質問状の回収不能（Questionaire A.B相方）、従って筆談にて調査を実施。

GIについてはタイミング、内容、明瞭性等問題はない。従って帰国研修員8名（全員）現場の技術者（セイロン製鋼公社7名、セイロン金属公社1名）である。応募者選考基準もGIにより適格になされている。

10－2　研修員所属機関

質問状の当着がおくれたがセイロン製鋼公社はGeneral Manager．Mr．Pereira他帰国研修員4名を含む計8名に会見、セイロン金属工業公社は質問状未到着であったが工場長及び帰国研修員に会見して以下その報告をします。

10－3　スリランカ民主社会主義共和国、製鋼事情

人　口	15.2百万人	（1982）	JICA
GNP	320トル	（1982）	〃
帰国研修員	1,708人	（1984）	〃
〃	130人	（1984）	NITC
〃	34人	（1984）	〃（金属関係）

鉄鋼生産量　0トン（注、別紙）

同上　世界平均年間生産量　157 Kg

同上　日　本　913 Kg

同上　スリランカ　0 Kg（注、別紙）

スリランカ民主社会主義共和国における1984年現在における鉄鋼生産量は現在0トンであり

Ceylon Steel Corporation（圧延等）

Ceylon State Hardwarelorporation（鋳鉄等）

が金属関係（鉄系）の公社である。

10－4　セイロン製鋼公社

所　長　　Mr．M．Pereira（別紙組織図参照）

従業員　　1,750人

施　設

電気炉　　25トン炉1基　15,000 KVA（ソ）

〃　　3トン炉1基　1,800 KVA

〃　　0.5トン炉1基　550 KVA

誘導炉　5 0 Kg炉1基　500 HZ

連　鋳　8 0中、112中（ソ）（4 Strand　1 0トン　タンディシュ　Open ）

S C　単位2.5 t

セメントボール　100 mmφ～20 mmφ

例　C　3.5～3.8　500 HB

Si　1.0 max

Cr　12～18

Mo　0.5 max

Tap－tap　2°30′の設計であったが実質5Hである。

電力原単位430 KWH／トンが実質1.000 KWH／トンである。

電力料金　1.75ルピー（ 18:00 － 21:00 ）

〃　1.20ルピー（他の時間）

耐火物については低Al_2O_3は国産（セイロン窯業公社）供給可能製鋼用は輸入に依存

従って原時点では輸入鋼材の方が割安であり、1982年にソ連の援助で完成した製鋼工場は休止中。同工場再操業のため2～3ケ月以内に国際入札を計画中。

尚、現在鋼材輸入（6,000ルピー／トン）のデータ（別紙参照）

尚当公社は年間圧延トン数は30,000 トンであり、当国の全体として32,000との報告を得た。当公社の従業員は総計1781名で、うち技術者4 9名、管理職5 9名、事務168名、技能職2 1 4名、その他である。

電極は日本より輸入、同径は400 mm、原単位9 Kg／t、酸素吹込なし、電気炉用耐火物高アルミナはオーストリアから輸入し、炉壁の寿命は180ヒート、天井110ヒート、炉床は500ヒートである。Fe－Si及びFe－Mnはノルウェイより輸入Fe－Crその他も他の国から輸入、連鋳は現在中止しているが、冷却水使用量は6 0 m³／連、開放型である。

尚、次に当工場生産の材質について一例を示す。

2 5トン電気炉による

C＝0.18～0.30　Si＝0.35 Max

Mr＝1.0 Max　P＝0.05 Max　S＝0.05 Max

鋳鋼

C＝0.2～0.3　Si＝0.05　Mr＝1.0 Max

P＝0.04 Max　S＝0.04 Max

ステンレス鋳鋼

C＝0.052～0.02　Cr＝18　Ni＝11

Si= 0.5 Max　　Mr = 0.5　　P = 0.05

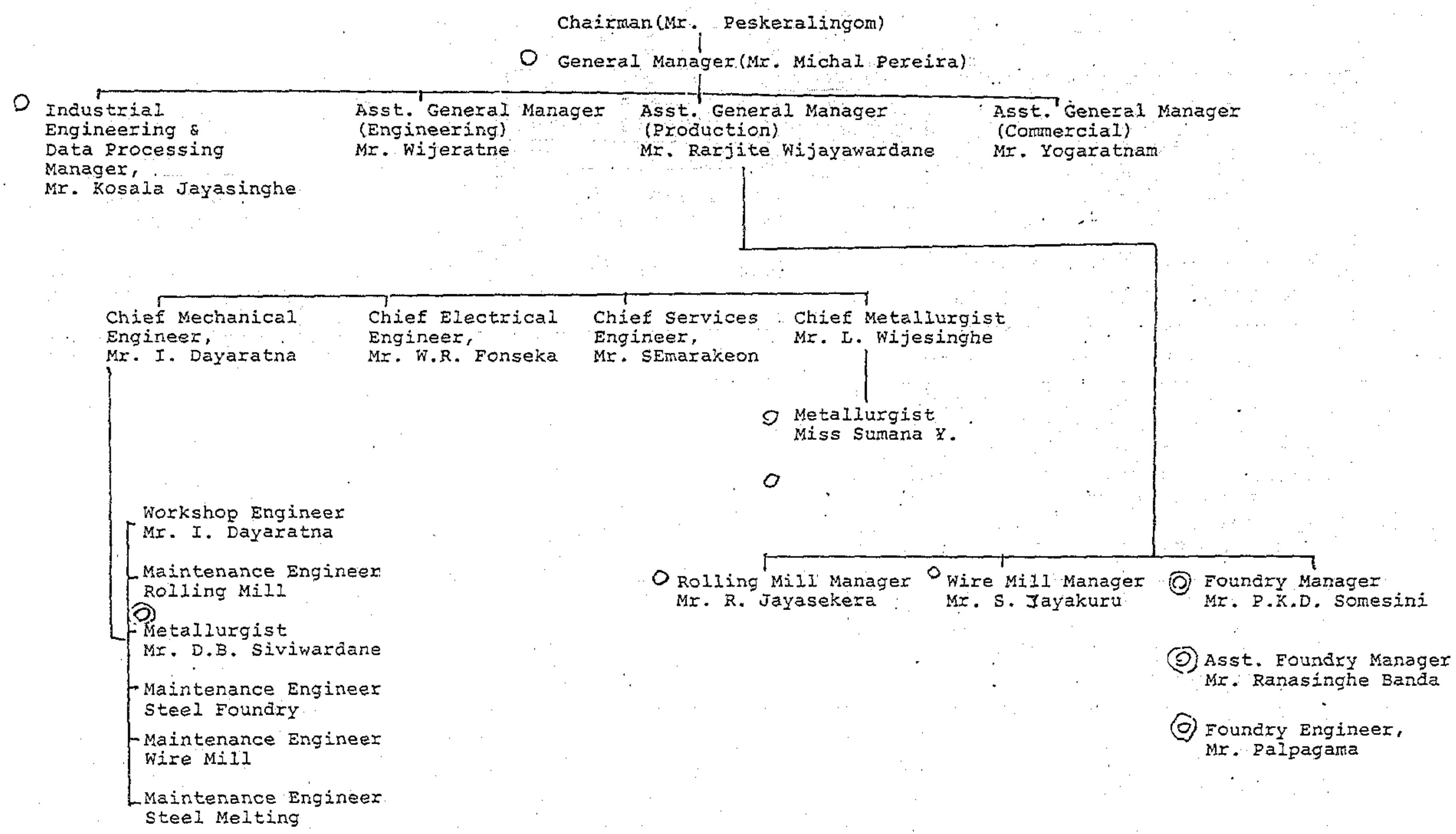
S = 0.05

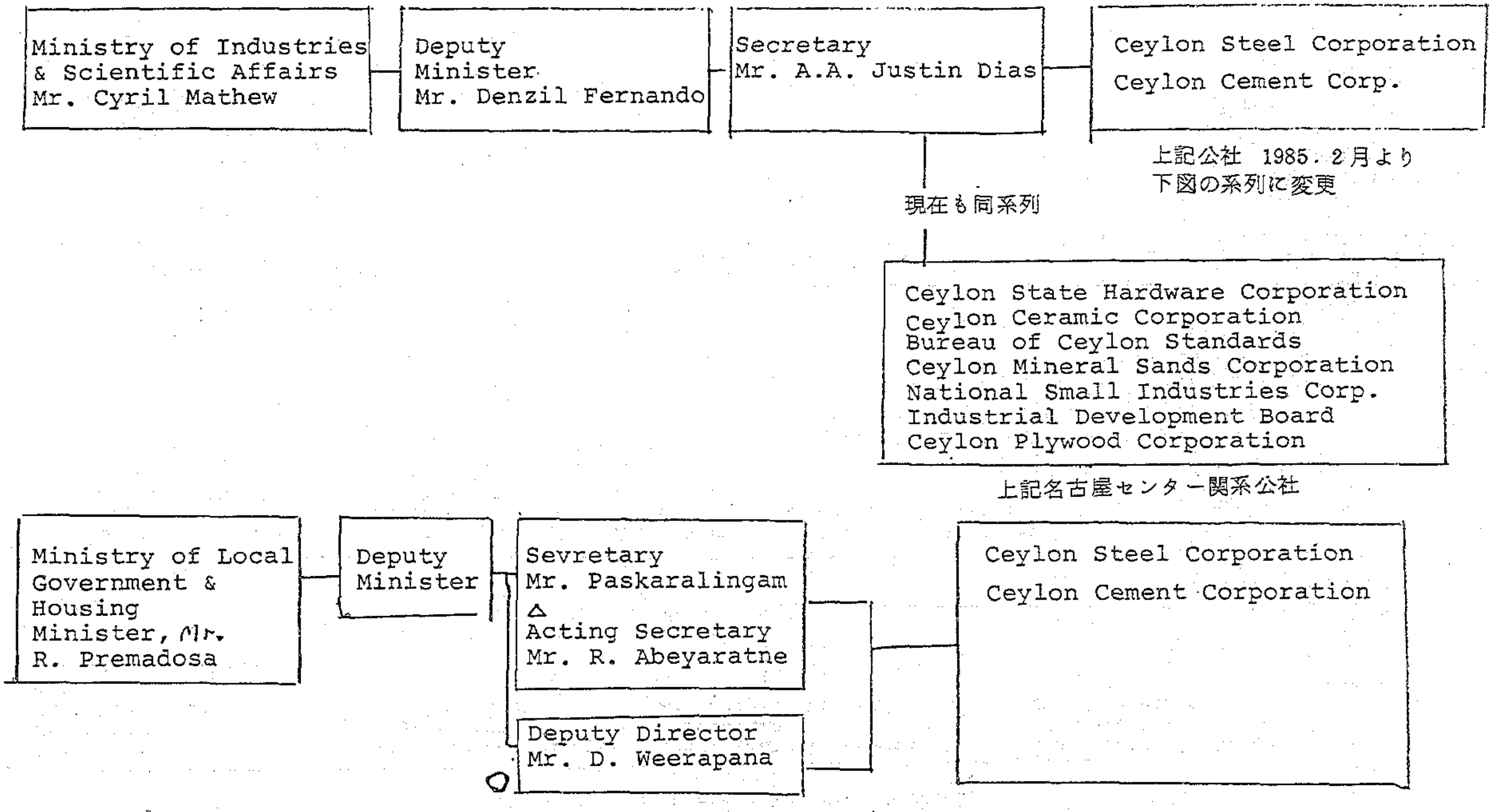
セメント用粉砕ボール（その他の例）

C = 1.5 ～ 3　　Si = 0.5　　Mr = 0.5　　Cr = 11 ～ 18

Mo= 0.5　　P = 0.05 Max　　S = 0.05 Max

CEYLON STEEL CORPORATION




Ministry of Industries & Scientific Affairs Mr. Cyril Mathew
Deputy Minister Mr. Denzil Fernando
Secretary Mr. A.A. Justin Dias
Ceylon Steel Corporation
Ceylon Cement Corp.
上記公社 1985．2月より下図の系列に変更
現在も同系列
Ceylon State Hardware Corporation
Ceylon Ceramic Corporation
Bureau of Ceylon Standards
Ceylon Mineral Sands Corporation
National Small Industries Corp.
Industrial Development Board
Ceylon Plywood Corporation
上記名古屋センター関系公社
Ministry of Local Government & Housing Minister, Mr. R. Premadosa
Deputy Minister
Sevretary Mr. Paskaralingam
△ Acting Secretary Mr. R. Abeyaratne
Deputy Director Mr. D. Weerapana
Ceylon Steel Corporation
Ceylon Cement Corporation

STEEL IMPORTS DATA OF 1983/1984

		'83 covering 12 Months	'84 covering 1st 6 Months
1.	PIG IRON (73.01)	47 M/T	92 M/T
2.	INGOT	-	-
3.	BILLET (73.07)	6,030M/T	6,168M/T
4.	RAIL (73.16A/B)	248M/T	158M/T
5.	SHEET PILE (73.11F)	68M/T	12M/T
6.	STRUCTURAL STEEL		
	1. H-BEAM) 2. I-BEAM (73.11A/B)	8,338M/T	632M/T
	3. CHANNEL) 4. ANGLE) 5. FLATS (73 HC/D/E)	114,924M/T	111,280M/T
7.	CARBON STEEL BAR (73 10BI To 10CA)		
	1. ROUND BAR) 2. DEFORMED BAR)	38,558M/T	397,040M/T
8.	WIRE ROD (73.10A)	1,420M/T	2,645M/T
9.	HOT ROLLED PLATES (73.13A)	11,331M/T	2,154M/T
10.	COLD ROLLED PLATES (73.13B/C/E2)	12,780M/T	7,936M/T
11.	TIN PLATES (73.13D)	5,287M/T	1,784M/T
12.	G.I. PLATES (73.12E2)	5,933M/T	3,724M/T
	TOTAL:-	204,964M/T	533,615M/T

IMPORT STATISTICS - JAN - JUNE 1984

	ITEM	COUNTRY		QUANTITY
1)	PIG IRON	U.K.		92 MT
2)	INGOT	-		-
3)	BILLET	AUSTRIA	5,850 MT	
		CHINA	299 MT	
		S/KOREA	19 MT	6,168 MT
4)	RAIL	U.K.		158 MT
5)	SHEET PILE	SINGAPORE	12 MT	12 MT
6)	STRUCTURAL STEEL (COVERING 3-4-5)	SINGAPORE	19 MT	
		U.K.	8 MT	
		ZAMBIA	15 MT	
		BELGIUM	22 MT	
		CHINA	130 MT	
		TAIWAN	711 MT	
		JAPAN	70,587 MT	
		RHODESIA	39,360 MT	
		S/KOREA	100 MT	
		S/AFRICA	297 MT	
		U.S.A.	20 MT	
		W.GERMANY	11 MT	111,280 MT
6)	STRUCTURAL STEEL (COVERING 1-2)	U.K.	15 MT	
		MALAYSIA	3 MT	
		SINGAPORE	53 MT	
		ZAMBIA	27 MT	
		BELGIUM	14 MT	
		S/AFRICA	342 MT	
		RHODESIA	32 MT	
		U.A.E	40 MT	
		TAIWAN	50 MT	
		SWEDEN	56 MT	632 MT
7)	CARBON STEEL BAR	AUSTRALIA	25 MT	
		SINGAPORE	570 MT	
		U.K.	189 MT	
		ZAMBIA	153 MT	
		TAIWAN	3,652 MT	
		JAPAN	1,803 MT	
		S/AFRICA	174,384 MT	
		RHODESIA	213,886 MT	
		CHINA	59 MT	
		CH	48 MT	
		W.GERMANY	639 MT	
		SWEDEN	942 MT	
		KOREA	690 MT	397,040 MT
8)	WIRE ROD	MALAYSIA	1,200 MT	
		U.K.	33 MT	
		TAIWAN	170 MT	
		FRANCE	199 MT	
		W.GERMANY	75 MT	
		JAPAN	487 MT	
		S/AFRICA	387 MT	
		RHODESIA	94 MT	2,645 MT

- contd -

I T E M	COUNTRY		QUANTITY
9) HOT ROLLED PLATES	SINGAPORE	27 MT	
	U.K.	15 MT	
	E.E.C.	28 MT	
	BELGIUM	590 MT	
	W/GERMANY	54 MT	
	JAPAN	164 MT	
USCO	S/AFRICA	1,258 MT	
	SAUDI ARABIA	18 MT	2,154 MT
10) COLD ROLLED PLATES	SINGAPORE	268 MT	
	U.K.	152 MT	
	BELGIUM	455 MT	
	TAIWAN	20 MT	
	JAPAN	2,433 MT	
	FRANCE	57 MT	
	W/GERMANY	924 MT	
	S/AFRICA	3,358 MT	
	SWEDEN	157 MT	
	U.S.A.	50 MT	
	OTHERS	62 MT	7,936 MT
11) TIN PLATES	U.K.	540 MT	
	FRANCE	84 MT	
	W/GERMANY	69 MT	
	JAPAN	750 MT	
	S/KOREA	205 MT	
	S/AFRICA	136 MT	1,784 MT
12) G.I. PLATES	SINGAPORE	39 MT	
	U.K.	7 MT	
	TAIWAN	14 MT	
	FRANCE	7 MT	
	W/GERMANY	8 MT	
	JAPAN	3,408 MT	
	S/AFRICA	241 MT	3,724 MT
	GRAND TOTAL		533,615 MT

10－5　セイロン製鋼公社評

イ）当国有一の製鋼所である当社はコロンボから約15キロのアツルギリアに設置、立地条件として、①川の近くである ②地価が安い ③主都コロンボより近い ④鉄道が計画されている ⑤政治的理由である。1982年にソ連の援助により25トン電気炉一基及び連鋳の設備が完成したが上述の理由により鋼材を輸入に依存（6,000ルピー／トン普通鋼）従って当公社は工業省から1985年2月に住宅建設省の管下へ移された。上記別表でわかるように当国の鋼材輸入は急速に増大し、1984年前期において53万トンを上回る状況にあり、当公社は鉄鋼生産ゼロであっても延30年間支払いの義務があり大変である。

近日中に国際入札により再スタートを計画中である。（年内に入札実施とのことであった。）

ロ）帰国研修員について

当製鋼所からは当国帰国研修員中7名が参加しているが、うち2名が退職し、1名が病欠であった。従って4名に会見した。4名中1名は製鋼部門Metallrrgist（Mr. Siriwardane）であり、本人は本コースに対して全般的に技術知識を習得でき有意義であったが、指導班が気が付かれたと思われるが種々問題が生じており我々のレベルでは解決不可能な問題が多々ある。近々製鋼部門の再スタートに際しては頑張る所存である。尚、本コースに対しては現場実習の時間増設と連鋳技術について再研修が要望された。

他の3人について、日本で得た技術、知識は相当なものであるが実行の段階に至って多くの問題に当面した。即ち、操業時間短縮、電力原単位低減をしたいが酸素を技術者レベルで購入できない、脱ガス技術導入も同様簡単な問題でない、また、一度上層部によって決定された事を下の者から変更することは不可能である。従って改善するには可成りの月日と理解者の数の増加が必要であり、日本に対し気長く見守って欲しく、且今後も一層の協力を要望された。尚これら3名は現在鋳造部門に所属しており帰国後球状黒鉛鋳鉄の製造に成功した由、また、一行が会見した中で熱処理コースに参加した研修員Miss Sumanaは帰国後、気体浸炭の実験をして居り成功した（以前、当社としては固体浸炭のみであった）由である。当社の鋳造部門のレベルは途上国の中でも平均的と思われる。

最後に質問状到着のおくれにもかかわらず回答書B及びC全部準備されており感謝に絶えません。

10－6　セイロン金属工業公社

総　裁　　Mr. P. A. D. Silva（別紙組織図参照）

従業員　　223名

施　設

電気炉　　3トン炉1基（必要に応じて操業）

誘導炉　　5トン炉1基 50 HZ

キュポラ　　5トン／H 2基（西独）中止

ＦＣ　　　　175トン／月

〃　　　　250トン／月計画

ＦＣＤ、ＳＣ計画中

生型、CO_2、油中子、友砂中子、ボンベイ・ベントナイト（Na系）４％

水分４～５％

水道用 Pipe、fitting、マンホール、制輪子、ポンプ、セメントボール、他

本型材は杉の一種を使用

10－7　セイロン金属工業公社評（１０月２５日）

イ）当社はコロンボより２０キロ以内に立地し、現時点においては主として上述のとおり５トン低周波炉により各種鋳鉄の製造をしている。生産性は別として技術者（経験者）は可成りおり、前述の製鋼公社よりも活気が見られ、技術レベルも途上国中、やや上位に属すると思われ、わが国が若干輸入している中国製鋳物と比較しても劣らない鋳肌を程している。当工場は、将来ダクタイル鋳鉄及び鍛造用工具鋼等各種小量の鋼の生産を考慮中であるが、第一歩としてダクタイルの方に手掛けた方がメリットがある旨指示した。

ロ）本コースの帰国研修員は本年６月に帰国し現在生産計画及び販売部長として活躍している。当人、所属先の現状から見て当然であるが鋳鍛造のテーマをもっと研修したい旨の要望であった。

Ceylon State Hardware Corporation

Chairman
Mr. P .A. D. Silva

General Manager
Mr. M. Korunaratna

Works Manager
Mr. L. B. Semasinghe

Engineer,
Production Planning
& Slaes,
Mr. J. J. K. Silva

Engineer,
Maintenance

Engineer,
Machine shop

Engineer,
Forge shop

10-8

SUMMARY REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA EX-PARTICIPANTS IN ELECTRICAL STEEL MAKING ENGINEERING COURSE

1. Introduction

Being dispatched by the Japan International Cooperation Agency as part of its technical follow-up programme for the ex-participants in the electrical steel making engineering course, the team consisting of three members headed by Mr. Jutaro Shimogo, Acting General Manager of Daido Steel Co., Ltd., arrived in Colombo on 22nd of October and conducted its follow-up activities for a period of 6 days.

The team has the pleasure to submit a summary report on the results of its study for the purpose of reference by the officials and engineers of the authorities concerned in the Government of Sri Lanka.

2. Team Members

(1) Team Leader, Technical Advisor:	Mr. Jutaro Shimogo Acting General Manager, Overseas Technical Cooperation Dept., Daido Steel Co., Ltd.
(2) Technical Advisor:	Mr. Ryuzo Komatsu Engineer, Continuous Casting Dept., Aichi Steel Works, Ltd.
(3) Coordinator:	Mr. Kanji Takeuchi Training Officer, Nagoya International Training Centre, JICA

3. Objectives

The dispatch of the team is primarily aimed at reviewing, assessing and evaluating the fruits of the training in Japan by visiting the organizations to which ex-participants belong, as well as through personal interviews with ex-participants and their superiors.

The second aim of the team is to have a technical discussion meeting in order to find out the needs, effectiveness and evaluations of the training programme, and to make further improvements for the training course.

4. Summary of the Follow-up Activities & General Impression

We conducted;

- interview with responsible officials of the government organization for selection of participants-nominating department,

- interviews with managers of two participant-sending organizations(Yakkala & Athrugiriya)

- interview with ex-participants,

- seminar with ex-participants and their superiors, responsible engineers and staffs and also officials related to this field.

Out of our discussion and observation, we could confirm the following ;

(1) The concerned personnel interview highly evaluate the results of the training in Japan, expecting at the same time the possible future further improvements of the training.

(2) Major reasons for high evaluation of the training programme are:

a) not only top level of steel plants in Japan but also smaller steel plants are included in the curriculum

b) plant maintenance including spare parts and necessary parts production techniques like steel casting are included in the curriculum

(3) Basic policy of candidate participant' selection has been made in Sri Lanka:

a) high level engineers have been nominated

b) nomination has been made exclusively to the people related to steel industry; Yakkala and/or Athrugiriya

c) such personnel in the position can give multiplier effect to steel industry in the country

We consider that the applicant selection(nomination) has properly and effectively been made in this country, SRI LANKA.

(4) Ex-participants are requested, upon their return to Sri Lanka, to report about the contents of the training to their sending organization(Yakkala, Athrugiriya), and their knowledge and techniques obtained are appreciated.

(5) The organization selecting participants-nominating department considers that the follow-up activities of this time are significant.

(6) All the ex-participants we interviewed have been trying their bestfor betterment of steel making by the use of obtained knowledge and techniques in the training in Japan

(7) All the participants we interviewed like to have technical information about the steel making in Japan.

(8) Steel industry in this country is starting and a lot of difficulties and problems have been under the solution, continuous casing is also under consideration and demad of steel is far from supply, especially alloy steels, however great efforts is made in the part and for the future. The team consider that the steel industry of this country will be in good expansion by thes peoples' efforts in near future.

Finally, the Team would like to express sincere appreciation and gratitude to the kindness and cooperation of the Government of Sri Lanka, Ceylon State Hardware Corporation, Ceylon Steel Corporation, the related people ofsteel industry in Sri Lanka, the Embassy of Japan, and the JICA Colombo Office.

The 26th of October, 1985.

Jutaro Shimogo
The Leader, the Follow-up Team for JICA Ex-participants of the Electrical Steel Making Engineering Course

List of persons met the team (Sri Lanka)

1. JICA Colombo Office

    Director, Mr. Jiro Hashiguchi
    Staff, Mr. Minoru Sasago
    Local staff, Mr. L.W.B. D'Olivera

2. Embassy of Japan

    Second Secretary, Mr. Masahiro Kobayashi

3. Ceylon Steel Corporation

    General Manager, Mr. Michal Pereira
    Manager, IE & Data Processing, Mr. Kosala A. J.
    Manager, Foundry, Mr. J.M. Ranasinghe B.
    Asst. Manager, " Mr. A.P.H. Perera
    Manager, Laboratory, Mr. Chamley A. Silva
    Asst. Manager, " , Miss Sumana W. Yapa
    Metallurgist, Mr. D.B. Siviwardane
    Foundry Engineer, Mr. Palpagama

4. Dept. of External Resources

    Deputy Director, Mrs. C. Amerasekera

5. Ministry of Local Government Housing & Construction

    Acting Secretary, Mr. R. Abeyaratne
    Deputy Director, Mr. D. Weerapana

6. Ceylon State Hardware Corporation

    Works Manager, Mr. L.B. Semasinghe
    Engineer, Production Planning & Sales,
    Mr. J. J. K. Silva

7. JICA Alumni Association

    Vice Chairman, Mrs. Doureen Porage

11 ま　と　め

11－1　ＧＩ及び受入れ研修員等について

各国ともＧＩのタイミングに問題はなく、また、各国における応募者選考基準についても、ＧＩ記載内容を十分考慮の上適格に該当者の選抜を実施している。

帰国研修員の実情は下記のとおりである。

条件	学歴（大卒）		経験２年以上	英語力
	冶金	機械		
トルコ	5	0	全員有資格者（平均5.6年）	全員十分
エジプト	8	0	〃（平均8.6年）	〃
スリランカ	6	2	〃（平均10.7年）	〃

尚、本コースの参加者は全員現場の技術者であることと、本コースのＧＩは窓口機関、所属機関等にとって、理解し易いとの評を得ている。

11－2　調査事項

イ）本コースの主要テーマである電気炉による製鋼技術及び最近途上国を含め世界的傾向にある。

連続鋳造等について調査がなされたが、その祥細については上述工場別調査の項を参照されたい。

下記にそのまとめとして一覧表を示す。

訪問工場	電気炉	連鋳	
トルコ（１）	アーク炉18.0t×1　3.5t×1 誘導炉 1.0t×1　5.0t×1	なし	スクラップ 20,000円／t 電力料金 13.2円／t （夜間50％）
〃（２）	アーク炉45.0t×1　15.0t×1	考慮中	
エジプト（１）	アーク炉25.0t×2　18.0t×1 3.0t×1　2.0t×1 誘導炉 各種×8	有り	スクラップ 在庫豊富 15,000円／t
〃（２）	アーク炉25.0t×2	〃	
スリランカ（１）	アーク炉25.0t×1　3.0t×1 0.5t×1 誘導炉50.0k×1	〃	スクラップ 在庫豊富 ￥10,000強／t 電力料金
〃（２）	アーク炉 3.0t×1 誘導炉 5.0t×1	なし	

ロ）相手国政府優先順位

相手国における産業開発等政府施策の中に占めウエートは下記のとおりである。

1. トルコ共和国

1）重工業（鉄鋼を含む）　2）その他

2. エジプト・アラブ共和国

1）食品加工　2）縫製　3）その他（鉄鋼を含む）

3. スリランカ民主社会主義共和国

1）住宅建設・整備　2）道路建設・整備　3）その他（鉄鋼を含む）

以上1985年現在である。

11－3 指導事項

祥細については各工場の項等を参照されたい。

訪問工場	現在	将来
トルコ（1）	1. 大型鋳物の補強 2. 上注から下注へ	1. 大型鋳鍛鋼 2. 平炉へ酸素吹込 3. ＣＣ．ＬＦ 4. 平炉→転炉
〃（2）	1. 造塊･圧延･仕上の強化 2. 湯道レンガ品質向上 3. インゴットケース再チェック 4. 二重定盤の採用	1. ＬＦ．ＣＣ導入 2. 各種耐火物の品質向上
エジプト（1）	1. ４Ｓの導入 2. 酸素使用 3. 整理整頓 4. 砂漠砂の吹込み防止	1. 浸せきノズル 2. 耐火物の検討
〃（2）	1. 計器等の見直し 2. ４Ｓの導入 3. 床面を平らに 4. 砂の吹込み防止	1. 浸せきノズル 2. 耐火物の検討
スリランカ（1）	1. 酸素使用 2. 鋳鋼の強化	1. 耐火物の検討
〃（2）	1. サンドイッチ法によるＦＣＤ 2. 日本の私鉄方式によるウラ金鋳ぐるみ制輪子製造	1. 鋳造補強 2. 鍛造用鋼

11－4　帰国研修員

一行は本コース帰国研修員21名のうちトルコ２名（２工場）、エジプト５名（２工場）、スリランカ５名（２工場）の計12名に会見、病欠２名、米国研修１名の３名を除けば現在も同じ工場に所属している全員と話す機会が持てた。

イ）研修プログラムに対し

1. インゴットケースの研修を考慮して欲しい

   Mr. Bulent　（トルコ製鉄所）

2. 有意義であった（全てよい）

   Mr. Levent　（トルコ特殊製鋼公社）

3. 日本との差を縮めるのが難しい

   Mr. Hamed, Mr. Kandel, Mr. Tawfik　（エジプト製鉄所）

4. 当工場は最近連鋳設備が導入されたが我々が日本で研修を受けた当時は、連鋳のプログラムが余りなかったので習得不十分であった。短期の最研修を考慮して欲しい。

   Mr. Radwan, Mr. El Latif　（デルタ製鋼所）

5. もっと少規模の工場研修を入れるべきである。

   Mr. Ranasinghe　他　（セイロン製鋼公社）

6. 鋳鍛造の研修をもっとプログラムに入れるべきである。

   Mr. Silva　（セイロン金属工業公社）

7. 現場に入り実習を主体とした研修を望む。

   Mr. Siriwvdane　（セイロン製鋼公社）

ロ）研修員の活動状況

別紙組織図で理解できるが

1.	Mr. Bulent	（技術部長）	トルコ
2.	Mr. Hamed	（製鋼部長）	エジプト
3.	Mr. Kandel	（連鋳部長）	〃
4.	Mr. Tawfik	（原材料部長）	〃
5.	Mr. Radwan	（製鋼部長）	〃
6.	Mr. El Latif	（連鋳部長）	〃
7.	Mr. Ranasinghe	（鋳造部長）	スリランカ
8.	Mr. Banda	（〃 次長）	〃
9.	Mr. Silva	（生産計画・営業部長）	〃

など夫々活躍している。

尚、本件とは若干相違しますが、トルコにおいて本年同窓会が発足、会員700名（1985、10月現在）、及びスリランカは現在200名であることを報告します。

11－5　本コースへの提案

イ）研修内容一覧表

主要テーマ	1984迄	今回 (1985)	主要テーマ	1984迄	今回 (1985)
基礎理論	6日	5日	電極等	2日	2日
アーク炉等	5日	5日	品質管理等	6日	6日
製鋼法	① 19日	※ 19日	保全管理	② 0日	※ 2日
原材量等	4日	4日	鋳鋼	③ 7日	※ 6日
耐火物	4日	5日	その他	5日	5日
連鋳等	9日	9日			

※①　普通鋼の増加　　②　タイミングを図りつゝ研修する

③　研修員の背景を考慮し加減する

④　鉱石法による製鋼法と酸素法の比較

ロ）解　説

ブラジル、インド、韓国のようにレベルが高い諸国は本コースの対象外とし、アセアン諸国、中近東その他諸国について、本コースの研修内容を考慮すると、

1.　製鋼用耐火物部門の強化
2.　わが国が過去に実施していた鉱石法と比較の上で製鋼法
3.　インゴットケースの再検討
4.　普通鋼並びに生産量の低い工場をも検討

以上の点に大別できるが、可能であれば研修の後半に専門別（レベル別）研修を実施すれば更に成果は大きいと思われる。

尚、製鋼技術の進歩は著しく将来再研修を考慮すべきである。

11－6　巡回指導への提案

イ）便宜供与依頼、Questionaireの早期発送

相手国内文書等の流れに時間を要するのでＧＩと同じ様に早く資料等を送付し十分な準備時間を与えるべきである。

ロ）Questionaireの重複送付

公的ルート用の質問状の他に写しをその旨明記し帰国研修員及びその所属機関へ送付し準備時間を十分にする。

12　参　考　資　料

SLIDE SCRIPT

PROGRESS OF THE ELECTRIC ARC FURNACE STEELMAKING PROCESS IN JAPAN

Digested from "DENKI-SEIKO" (ELECTRIC FURNACE STEEL)
Vol.56 No.1 1985 Page 63-79
Originally written by Mr. Goro Yuasa, R&D Div. Daido Steel

Speaker: Jutaro shimogo
Acting General Manager

GREETING

We are the follow-up team organized and dispatched by the Government of Japan through the Japan International Cooperation Agency (JICA) with the duty to achieve the following objectives.

1. To offer the necessary guidance through the technical consultations with the ex-participants

2. To evaluate the effectiveness of the technical training given to the ex-participants

3. To assess the urgent needs and the major problems in the fields of electric steel making operation.

4. To further improve the JICA's technical training programme

As one of the means to achieve the objectives, we have mailed you questionaire to effectively obtain the necessary information from your organization. We sincerely thank you organize the kind cooperation in completing our task on behalf of our government. We would like to have sufficient time to discuss whatever matters were not presented in our questionnaire.

Let me introduce our Members of the Team

1. Mr. Kanji Takeuchi, Coordinator of our mission
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PREFACE

The electric arc furnace steelmaking counts its 85 years' history since the French metallurgist, Heroult, first applied electric arc furnace for steelmaking in 1899. The both converter process and the open-hearth process have been sustaining the modern steelmaking for as many as 120 to 130 years. The electric arc furnace steelmaking has made drastic advancements in these years in the fields of equipment and metallurgical operation.

It was considered the electric arc furnace steelmaking process was to be seriously affected by the energy crisis in 1973, but it made incredible advancement in energy saving, labor saving, productivity, etc. during the last decade. On the contrary, it recorded increase of 10% in crude steel production ratio, with the ratio jumping from 18% to 28.4% in 1983.

Today I would like to make a review of the history of electric arc furnace steelmaking, and tries to investigate the reasons leading to its leap and to make clear the strength of this steelmaking process contained in order to prospect it's development in the future.

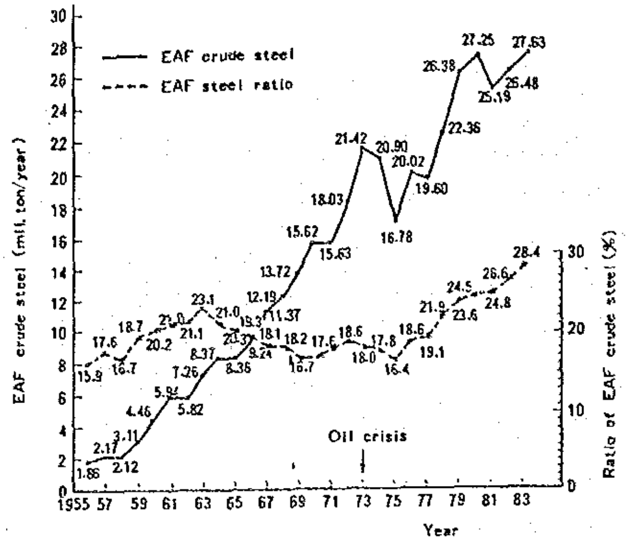


Fig-1 Growth of EAF crude steel and the ratio to total steel production in Japan

1 Outline of present status

Fig-1 shows the growth rate of electric arc furnace steel production in Japan. The oil crisis brought a turning point the high economic growth for on development of electric arc furnace steelmaking in 1973. The power rates after the crisis soared up by four times.

However, the strained feelings in this industries towards the threatening critical moments was possibly the driving force for promotion of technical improvements.

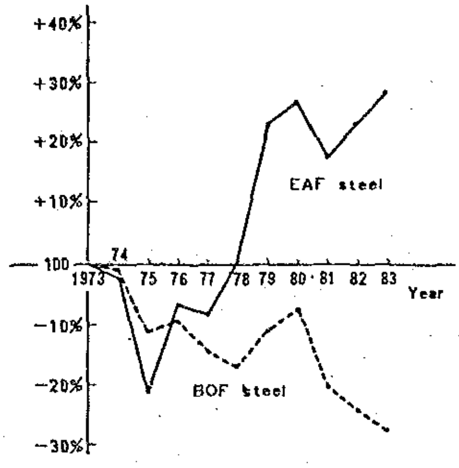


Fig-2 Growth of EAF and BOF crude steel (production in 1973=100) Acoording to statistics by Japan Iron and Steel Federation (JISF)

Fig-2 shows the steel production by electric arc furnace began to rise, approaching to 30% in these ten years. The converter steel diminished by the amount equivalent to the increment of electric arc furnace steel.

The changes brought about in these two types of steels show a sharp contrast in Japan. The year 1973 when the oil crisis bursted, was also the year when the crude steel production quantity in Japan marked the epochal level of approximately 119 million tons. The growth rates of both converter and electric arc furnace steels are compared in Fig-2 with this year (1973) as the base. The electric furnace steel production in 10 years marked 30% up against approx. 27% down of the converter steel.

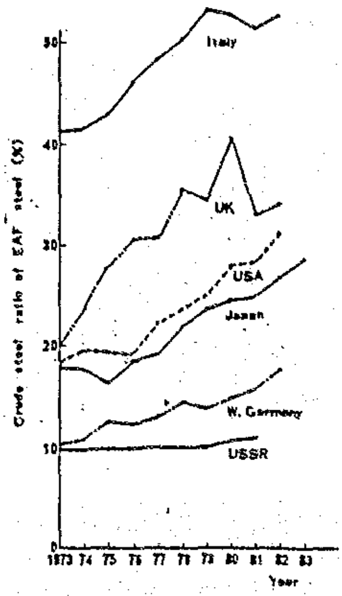


Fig-3 Yearly percentages of EAF steel to total crude steel production in major steelmaking countries (JISF)

In 1973, the production of electric arc furnace steel marked 27.6 million ton and made a new record. This drastic growth of electric arc furnace steel is also a global tendency. The transition of electric arc furnace steel ratio of main steel producing countries against the crude steel is shown in Fig-3. The figure shows a remarkable growth of electric arc furnace steel ratio in each country in the past 10 years. There is a large difference in country-wise ratio.

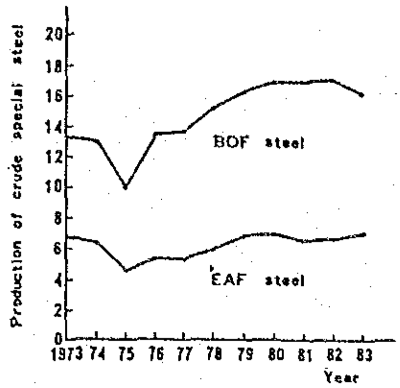


Fig-4 Furnacewise classification of crude special steel (JISF)

2. Background for development

Fig-4 shows the transition of furnace-wised production quantity of special steel during this period. The production ratio of converter steel to electric arc furnace steel is now 60/40, but it was approximately 50/50 in 1973.

The special steel production marked 40% growth rate in this decade, but most of the increment was supplied by Basic Oxygen Furnace.

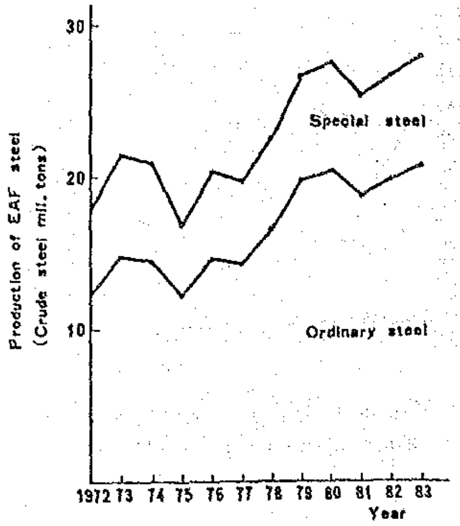


Fig-5 Change of EAF steel production and the steel grade (JISF)

As shown in Fig-5, the special steel hardly covers one-fourth of the total quantity of EAF steel.
It is the ordinary steel that has contributed to the growth of electric arc furnace.

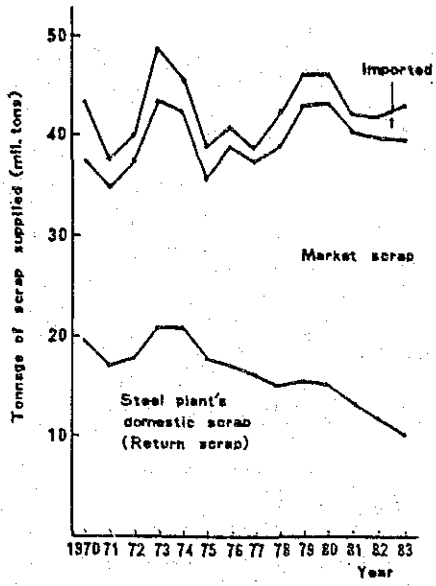


Fig-6 Supply of steelmaking scrap in Japan (JISF).

The world-wise increase in electric arc furnace production quantity can be attributed to the increase of the amount of steel scrap. Moreover, the decline of open hearth process capable of much more consumption of scrap than the basic oxygen furnace provided the electric arc furnace with a favorable condition for raw material.

As shown in Fig-6, the supply quantity of scrap itself, with 40 million ton per year, hardly shows any change. But the scrap generating structure has largely changed. The revert scrap generated at each steelplant is showing sharp fall due to adoption of continuous casting process, while the market scrap showing increase every year.

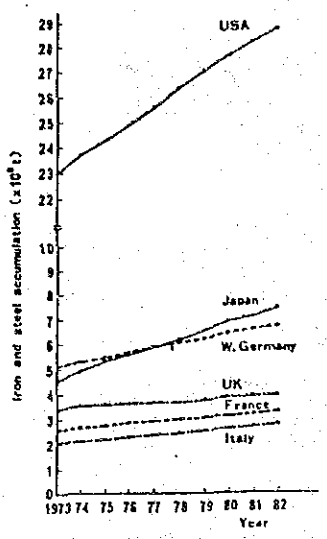


Fig-7 The change in accumulated amount of iron and steel in major steelmaking (JISF)

The change in accumulated amount of iron and steel regard as the source of market scrap in each country is shown in Fig-7.

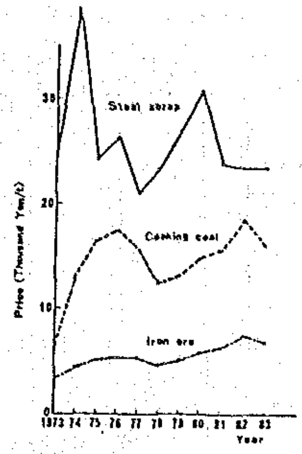


Fig-8 Comparison of prices after oil crisis between scrap, iron ore and coaking coal (JISF)

The rise in energy cost is considered as the most serious problem during oil crisis. But it did not very much deteriorate the competitive power of electric furnace. Because the increase in costs of power consumed for melting and electrode, was clearly big problem, but then the total cost of raw material for blast furnace and converter processes also rose to almost an equivalent level. Fig-8 shows the comparison at prices after oil crisis between scrap and iron ore/coaking coal. As shown in the figure, though a large fluctuation is seen in the price of scrap, the overall price has not risen since the oil crisis, while the prices of iron ore and coaking coal for blast furnace has risen to two times and three times respectively for the past ten years.

This rather provided the electric arc furnace an opportunity to maintain its competitive power due to the "relatively low price" of scrap. However, was one more factor - the appearance of secondary steelmaking process - that endangered the very existence of electric arc furnace process. As the secondary refining processes with extremely high refining levels and efficiency as well as excellent reproducibility prevailed, the high grade and special steels were no more the exclusive property of electric arc furnace. Now, the converter steel depending on secondary refining increased remarkably.

Table-1 Progress of the steelmaking operation by EAF and the equipment involved

	Furnace design and auxiliary equipment	EAF Operation/Refining and Ingotmaking	Tap to tap time (min)	Power consumption (kWh/t)	Remarks
1945	Side charging (Open hearth type); (Electrode control) Balance relay, Amplidyne	Ore steelmaking; Ingot/Top pouring	360 - 480	Up to 800	Bath analysis/chemical(titration)method
		Oxygen steelmaking			
1955	Top charging; Induction stirring	O_2 refining of high Cr-steel; Degassing (Vacuum casting)	240	850	Instrumental analysis (Emission spectroscopic)
	Use of larger capacity (over 30t)	Bottom pouring			Direct suction for dust collecting
	Water cooled panel	RH degassing	180	650	
1965	Thyristor	Sliding nozzle			Fluorescent X-ray analysis
	Oxy fuel burner; Application of UHP	Stainless steel refining(AOD/VOD); Ordinary steel by CC	120	500	Application of computer for analysis
Oil crisis					Building dust collection; Power demand control
1975	Water cooled roof	Oxygen enrichment melting; Carbon injection; Refining by LF	90	450	
	Scrap preheating	Special steel by CC			J-comp (Prediction of hardenability)
	Vacuum slag cleaner	Combined steelmaking line	70	420	Enclosing dust collection (sky house)
1985					

3 Improvement of furnace operation

The main changes brought about in overall electric arc furnace steelmaking given in Table 1. The top charge furnace appeared as the first modification, which reduced the waiting time for power input by more than one hour. Next came the oxygen-enriched steelmaking, which largely contributed to the acceleration of melt-down, reduction of decarburization time and improvement in temperature raising efficiency. Furthermore, instrumental analysis was developed and adopted, contributing largely to the shortening of reduction applied in about 1960, decisively reducing the operation time by half, and bringing the tapping cycle of electric furnace up to 8 heats per day. The introduction of oxygen-enriched steelmaking further led to drastic improvement in stainless melting enable to remelt high-Cr contained revert scrap. The former stainless melting was simple remelting stainless scrap only and then added low carbon ferrochrome at excessively high temperature.

Table-2 Installations of existing EAF in Japan by year and capacity (JISF)

Year			1949 or before	1950 - 1954	1955 - 1959	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1979	1980 -	Total
Whole situation	Furnace capacity	Up to 8t	55	9	15	33	34	23	10	-	179
		10 to 15	14	4	11	12	7	5	2	-	55
		20 to 25	3	1	3	7	6	16	-	1	37
		30 to 45	-	-	8	18	7	21	7	-	62
		50 to 60	-	-	-	10	5	27	5	2	49
		70 to 80	-	-	-	4	4	5	2	2	17
		90 to 100	-	-	-	1	-	2	3	2	8
		Over 110t	-	-	-	1 (200t)	1 (120t)	1 (120t)	3 (150t, 140t x 2)	-	6
		Total (units)	72	14	38	85	64	100	32	9	413
		Average capacity (t)	6.7	8.0	13.7	25.7	20.8	34.0	45.8	67.8	24.2
Increase of big furnace and change to high power	30t Furnace	Number of Installations			8	35	17	56	20	6	142
		Average f'ce capacity (A) (t)			31.9	50.8	54.7	51.3	69.0	73.0	53.8
		Average transformer capacity(B) (MVA)			12.8	20.9	22.3	26.4	35.0	56.7	26.1
		Furnace vs transformer (B/A) (MVA/t)			0.401	0.412	0.407	0.515	0.507	0.756	0.484

4 Improvement of furnace equipment

Table-2 classified electric furnaces currently possessed in Japan capacity-wise and installation-year-wise. The installation of large-size furnaces with capacity over 30t started in 1955, and the number of such furnaces kept on increasing year by year, with the total number presently reaching to 140 units. They cover 34% of the total number of furnaces in Japan. This led to the net average furnace capacity to increase to 24.2t. In the lower part of Table-2, the specific transformer capacity (MVA/capacity/t) of large furnace is compared. This figure goes sharply up since 1970 and shows the spread out of the UHP furnace. This figure increase further in recent years, showing the second leap of UHP furnace technology.

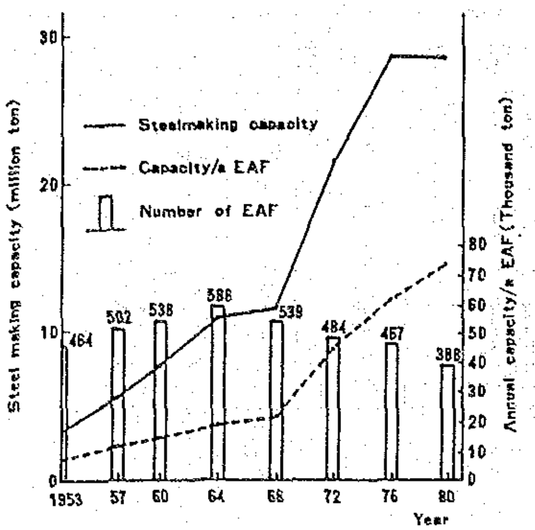


Fig-9 Change of production capacity and number of EAF in Japan (JISF)

The growth of production quantity is shown in Fig-9. The great leap in capacity was attributed to the trend of installation of large-size and ultra high-powered furnaces.

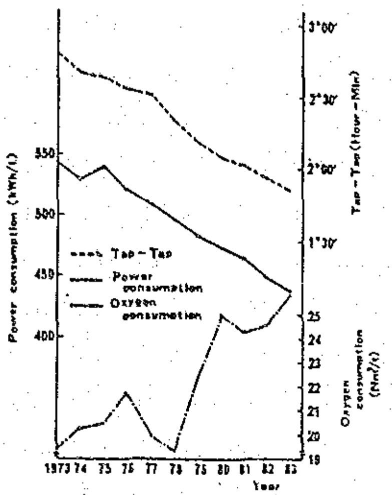


Fig-10 Change of steelmaking time, power and oxygen consumption in EAF

(Average value of 146 furnaces in member companies of JISF)

5 Overcoming the Oil Crisis

Various steps were taken to save energy since power saving in electric arc furnace steelmaking. It could directly lead to additional production quantity. An effective process put to work by some company would soon prevail over the whole steelmaking industry. Investment on energy-saving equipments started. This contributed to rationalization in related fields as well. The spread of continuous casting machine is a typical example. The successful reduction of heat time and power consumption during the period of ten years after the oil crisis is shown together with the saving of oxygen consumption in Fig-10.

Remarkable improvements have been made during this ten years. For example, the average heat time (tap-tap) of 1 hour and 51min and power consumption of 439 kWh/good ingot ton was achieved in 1983. The saving rates in ten years are 33% and 20% respectively. Technical innovation have been done also. It brings drastic change in the traditional conception of melting and refining on electric arc furnace steelmaking.

- Water cooled panel and roof
- Oxygen-enriched furnace operation
- Injection of carbon powder
- Specialization of refining in series of molten steel vessels, i.e. Combined refining process.

The oxygen-enriched operation is a technology different from the conventional conception of blowing oxygen into the molten steel only for decarburization.
It is a technology for reducing power consumption by accelerating scrap melt-down with the oxidizing heat of metallic iron charged. The oxygen blowing starts immediately after the scrap melting and continues till scrap melt-down. The effect in actual operation is extremely distinct, with the melting time apparently shortened and the power consumption reduced in proportion to oxygen consumption. This brings about strong excess oxidation due to increase of ferrous oxide content in the molten slag and oxidation of carbon content in molten steel. The carbon powder such as fine cokes began to be injected into the molten steel for reduction of the ferrous oxide as well as for elimination of the excess oxygen. However, since the reduction of FeO by carbon is a strong endothermic reaction, the required heat is supplied with powering of the furnace transformer. Theoretically, the difference in heat generated at oxidation of iron and heat required for carbon reduction of ferrous oxide is equivalent to the C - CO oxidizing heat. Though it is not so big in calorie, this heat logically contributes to reduction in power consumption. In actual operation with carbon injection, the CO gas generated during reduction of FeO, makes foamy slag caused by bubbling. Foamy slag operation leads to formation of submerged arc giving high thermal efficiency favoured by extreme reduction in radiation loss. Accordingly, heating efficiency was improved from approximately 30% in normal flat bath to over 60%. Foamy slag opeation contributes remarkably to the reduction in power consumption and heat time required for raising the temperature. The oxygen enrichment comes to promote steelmaking by adding C, which basically had to be eliminated. Thus the oxidizing period in a strict or traditional sense disappeared practically after melt-down. then the bath temperature is raised to the full capacity of the power source.

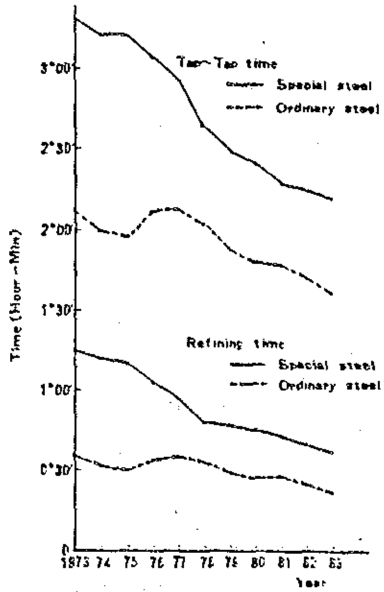


Fig-11 Change of steelmaking time (Tap-Tap time) and refining time in EAF (JISF)

Fig-11 shows shortening of heat time on both special steel production and plain carbon steel production by electric arc furnace in Japan.
The considerable saving of plain carbon steel production is furnished better than that of special steel production.

The average tap-tap time of 79 units (as of 1983) of special steel making furnaces has reduced to 1 hour and 6min and the refining time was shortened by 38min. But there is still a large difference between those figures and the figures for plain carbon steel production. For instance, there is a difference of 15min in the refining time. It is believed that this difference will be cought up with the further adoption of secondary refining process in special steelmaking.

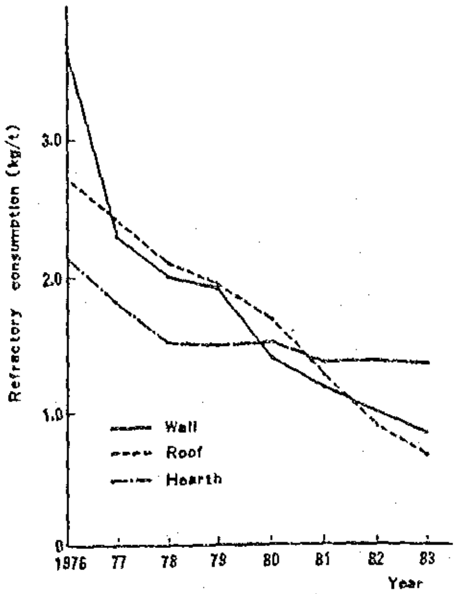


Fig-12 Change of refractory consumption in EAF (JISF)

One of the many thier important progresses is the adoption of Water Cooled Panel. Fig.12 shows the saving of refractory consumption of electric arc furnace. The furnace hearth refractories were reduced roughly to 60% in a period of 7 years since 1972, while refractories for roof and side wall were remarkably reduced to one-fourth. Such drastic saving is attributed to the adoption of semi-permanent Water Cooled Panel in the place of side wall brick. This plays indispensable role for solving the hot spot problem of severe errosion of refractories especialy in UHP electric arc furnace.

Saving of electrode consumption have been made from 5.1kg/t in 1973 to 3.4 kg/t in 1983. The rate of reduction is 33% in this decade. Since the price of graphite electrode like the power rate, has zoomd up four times since the oil crisis, the reduction of electrode consumption has really played important roles in reducing the product cost.

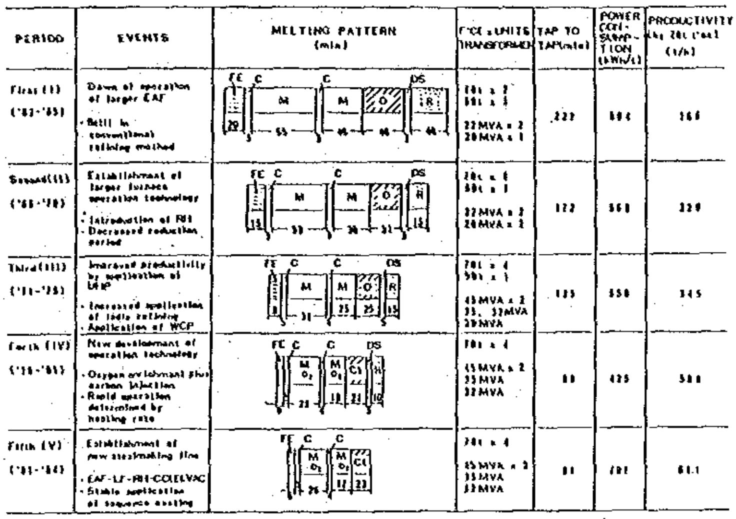


Fig-13 Changes in the operation technology of EAF at Chita Plant (Daido)

Note) FE: Fettling C: Charging M: Melting O: Oxidation DS: Deslagging
R: Reduction CI: Carbon injection and heating-up

6 Progress in operation in Chita steelmaking plant.

So far an overall view has been taken on the advancements on electric arc furnace in Japan, it might be interesting to know the progress made in a certain plant. Fig-13 shows the change in melting pattern and operation (running) efficiency of electric arc furnace in our Chita Plant, Daido Steel, Nagoya, Japan.

Chita meltshop, Daido having four-5.8m arc furnaces, two-RH degassing unit, two-Daido Ladle Furnace and one-2strands bloom casting machine is enable to producing 120,000 metric ton of steel per month by means of 4 crew x 3 shifts operation. The furnace operation since 1960 can be classified into 5 stages as shown in the figure.

The first stage was the start-up period of this large electric furnace plant, with the operation pattern basically remaining the classical type refining process. The total heat time by taking usual oxidation period, deslagging, slag renewing and normal reduction refining was 3 hr 40 min.

In the second stage, the RH degassing unit were introduced to contribute simplification of reduction period and degassing. However, the total heat time in this stage still remained at approximately three-hour level.

The third stage was that of UHP furnaces. when the steelmaking could be carried out for 2hours. The fourth stage brought basic changes in electric arc furnace operation, and the melting time was further shortened in large extent; in the meantime, the power consumption was also drastically reduced. Since reduction of power consumption was the prime object after the oil crisis, the record of power saving of 125 kWh/t. 25% saving against the preceding stage was fairly above the objective level. The sharp reduction of power consumption attributed to the oxygen enriched operation, the incredibly high effect of oxygen enrichment was successfully proved again. The injection of carbon powder carried out linked with oxygen enrichment and the operation shifted to "temperature rise rate-determining" type.

In the fifth stage, the combined refining with LF as well as continuous casting was established. The most of refining period was entirely shifted to LF. In this stage, the steelmaking complex: EAF-LF-RH-CC for producing high grade steel was completed, and the specialization of refining due to each process was established. The combined steelmaking complex proved most effective refining and this leaded to the most economical and rational steelmaking.

Summing up the progress made over these 20 years in operation of 70t furnace in Chita Plant, Daido since 1960, the heat time was shortened by 64% of the time at start-up stage, and the power consumption was reduced by 28%, while the steelmaking efficiency in all increased to an outstanding 3.68 times level.

Table-3 Quantitative effects of power reduction (Reduction at the level of about 500kWh/t)

Means of reduction	Quantitative effects	
High power application	28kWh/t	Increase of power source capacity per 100kW/t
Reduced tap to tap time	20kWh/t	Reduction of time per 10min
Operation with oxygen enrichment	44kWh/t	Increased oxygen consumption per $10Nm^3/t$
Scrap preheating	40kWh/t	Preheated up to 300-400℃

(From IISI SCE data)

The UHP furnace and oxygen enrichment were introduced as the measures for rationalization in Chita Plant, Daido. Their quantitative effects are shown in Table-3. The figures in this Table-3 are based on the values submitted by Sub-committee on Energy (SCE) of IISI. Table-3 shows that the oxygen-enriched operation is one of an attractive power-saving measure. Supposing that 44 kWh/t power is saved by using 10Nm3/t of oxygen, then the power cost of ¥660/t can be saved by investing ¥250/t for oxygen.

Table-4 Installation of secondary refining for EAF in Japan (As of 1983)

Process	DH	RH	LD*	LF	ASEA-SKF	VAD	VOD	AOD
Units	3	6	14	21	3	2	8	13

*Ladle degassing in vacuum tank

7 Secondary Refining Process

The secondary refining process and continuous casting process affected the biggest influence on the operation of recent electric arc furnace steelmaking. Out of the refining systems, the vacuum degassing was introduced in the electric arc furnace process in the 1960's, followed by various treating processes such as vacuum casting, ladle degassing, RH process, etc. The stainless refining AOD process and ladle refining furnace, were introduced, ten years later, in 1970's. Table-4 shows the number of secondary refining equipments used in electric arc furnaces currently running in Japan.

Table-5 EAF steel tonnage treated by different secondary refinings

Unit: good ingnt ton X 1000 (in 1983)

Refining	V (LD)	DH	RH	LF-V	LF-RH	LF	ASEA	VAD	VOD	AOD	Total	EAF crude steel	Ratio of secondary refining (%)
Annual tonnage treated ($\times 10^3$)	417	30	882	487	1640	2004	166	143	143	782	6674	27629	24.2
				LF total: 4131				Ordinary steel:			1175	20539	5.7
			RH total: 2522					Special steel:			5499	7090	77.5
	V(LD) total: 904												

The current treated tonnage of electric arc furnace steel by the secondary refining processes is shown in Table-5.

Out of the 27.6 million ton of electric arc furnace steel in 1983 in Japan, some 6.67 million ton was treated by at least the one of the secondary refining processes. The treatment ratio became to 24%. However, there is a large difference in secondary refining ratio between the plain carbon steel production and the special steel production. The former amounts to 1.17 million ton (5.7%), while the latter amounts to 5.5 million ton (77.5%). The ratio of secondary refining of special steel production exceeds 90%

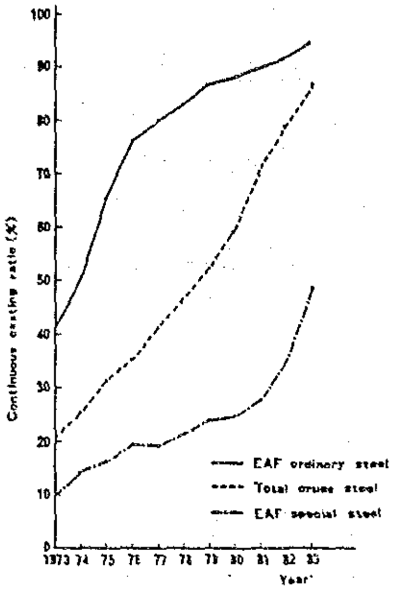


Fig-14 Change of continuous casting ratio in EAF (JISF)

8 Influence of Continuous Casting

The continuous casting process for plain carbon steel production by electric arc furnace had been introduced with a high rate in the whole iron and steel industry. In 1973, it was already at more than 40% level while the CC ratio of total crude steel was 20% level. Needless to say, the continuous casting process has a number of aspects; yield increase, reduction in labor for ingot making, omission of blooming, energy saving and rationalization. So it was promptly introduced for plain carbon steel production on EAF having large portion of rolled product and steelgrades easy to teem. Fig-14 shows the comparison of continuous casting ratios for total crude steel production, plain carbon steel production and special steel production on EAF in Japan.

The changes in ratios show sharp contrast, with the ratio for total crude steel exceeding 80% and still showing linear upward trend, while the ratio for plain carbon steel production shows a sharp rise until 1976, and in spite of reduction in rising speed, has attained a high level of 95%. In this field, the adoption of continuous casting seems to come to the saturation point. In the case of special steel, on the contrary, the continuous casting ratio showed an increase lately in 1980's, and went on increasing rapidly to the present level of 50%.

Hence, there is still many potentiality for continuous casting in special steel production on EAF.

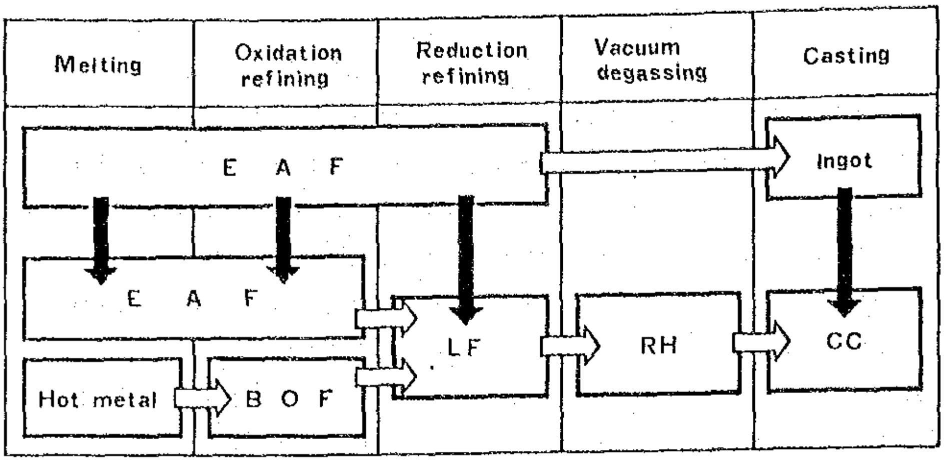


Fig-15 Development of steelmaking process of high grade steels

The new steelmaking line equipped with continuous casting process combined with aforesaid LF and RH processes not only improves the standard of refining but also ensures functions required for smooth sequencial casting operation. The LF can provide all such functions for sequential continuous casting operation.

LF is indispensable to the process rationalization of meltshop. The combined steelmaking line with LF and RH linked with CC, has been currently installed one after the other in plants carrying out mass production of high grade steels. It is getting to occupy the main position of the typical melting process. Fig-15 summarizes the comparison between this process specializing in melting function and the conventional melting process using only the electric arc furnace.

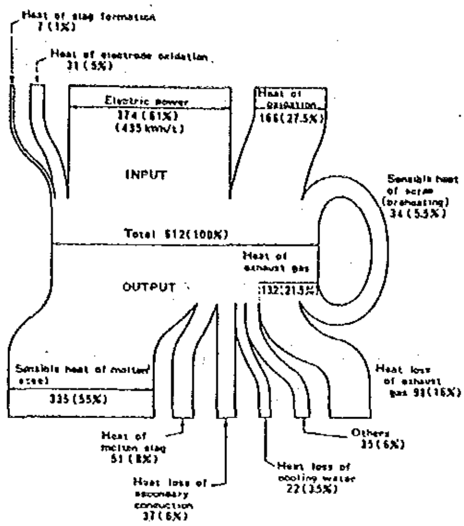


Fig-16 Heat balance of 25t EAF with scrap preheater (Mcal/t)

Scrap Preheating system is also imformative you.
Fig-16 shows a heat balance in a 25t furnace with scrap preheating equipment (Shibukawa Plant, Daido). The transformer capacity of this furnace is 20 MVA and the tap-tap is roughly 100 minutes, and oxygen enrichment and C injection are carried out.
The power consumption of 435 kWh/t actually accounts for no more than 61% of heat input, practically being not so different from the sensible heat (55%) to be provided to the molten steel.

In this analysis of Fig-16, power consumption is logically almost saturated. It seems to be no room for further reduction in power consumption. In order to reduce the electric power, therefore, the substitute energy is essential. In the recent years, the oxidizing heat of C, Fe, etc. is applied. This calorie is now reaching to 30% in the current furnace operation. Large amount of carbon is expected to be used in electric arc furnace for reducing the power consumption. This means the increase in waste gas amount and then results in carrying off of a large amount of calorie by the waste gas. Hence, scrap preheating will become all the more important for the effective recollection of the sensible heat.

9 Future Prospect

(hereinafter, Speaker's comment by Mr. J. Shimogo, Daido Steel)

The magnificent achievements made by secondary refining in all refining fields has released the electric furnace from the refining process to determine the quality. Main object of electric arc furnace solely "how to carry out melting efficiently and economically". On the electric arc furnace steelmaking, we are sure to keep improvements in performance and operation on. The achieved average values of electric arc furnace in Japan show that the heat time and the power consumption will be further lowered.

Now, I referred you the latest development of electric arc furnace steelmaking and its related technologies very shotly. Fast growth of electric arc furnace steelmaking partly depended on the low utilization ratio of scrap charged into Basic Oxygen Furnace (converter), but as you might know, high scrap charge ratio treatment on BOF operation is also developing, such as KS process in West Germany which makes larger consumption of scrap available.

But thinking from the side of electric arc furnace steelmaking, the utilization of Direct Reduced Iron ore reaches the industrial level already. Despite of the increased specific energy consumption which results from the use of DRI, it does allow better consistency in electric arc furnace steelmaking to be achieved. Where premium, low residual qualities are required, this consistency will prove advantageous, as will lead the simplification of post-refining operation and will connect the secondary refining process having much flexibility and potentiality.

As I mentioned you earlier, electric arc furnace steelmaking is still developing by accumlation on integration of various technologies:DRI, Scrap pre-heating, oxygen enrichment, carbon injection, oxy-fuel burner, Water Cooled Panel, Water Cooled Roof, bottom tapping hole, open tap hole process, Vacuum Slag Cleaner, Ladle Furnace, Vacuum treatment of molten steel, Gas stirring in ladle, Powder injection into ladle, AOD, CCM etc.
Therefore I am rather optimistic to future presence of electric arc furnace steelmaking.
In fact certain electric furnace meltshops are enjoying very low power cost favoured by plenty amount of hydraulic power station and/or much resources of natural gas stored in their countries.
I would like to mention our future on EAF steelmaking advantages of EAF steelmaking are as follows;

- Flexible operation due to demand.
- Small or stepwised investment along with steel market requirement.
- Multi source to be charged regard as raw materials.
- Possibility of lower energy cost by diversion caused by the utilization of carbon injection/oxygen enrichment.
- Future nuclear power station may offer cheaper power cost scheduled.
- DR-EAF process plays indispensable role in the future nuclear steelmaking process linked with High Temperature Gas Reactor (HTGR).

Thank you for your keen interest and your kind listening.

ACKNOWLEDGEMENT

We leave this nice country with many pleasant memories, our mission was able to complete the task by virtue of kind cooperation of many people concerned in public and private sectors as well as (State Planning Organization of xxxxxxxxx), for which the mission extends sincere gratitude.

It should be specially mentioned that at each of the company, people of the work took kind guide to our mission for many hours despite of their busy conditions and sparing precious time.

Because of tight schedule, our mission is afraid to leave the site without expressing our hearty appreciation to all of them whom we met. Our mission takes this opportunity to extend sincere gratitude. Please forward our regards to them.

Otherwise there may be the possibility of erring in important judgement as conceivable from the unintetional misunderstanding. This is the most of our concern.

If you have any question to us, please freely contact us in letter.

We would like to reveal such matter soon.

Finally if you have a chance to visit our country Japan. Please contact with JICA, Nagoya, Japan.

- FIN -

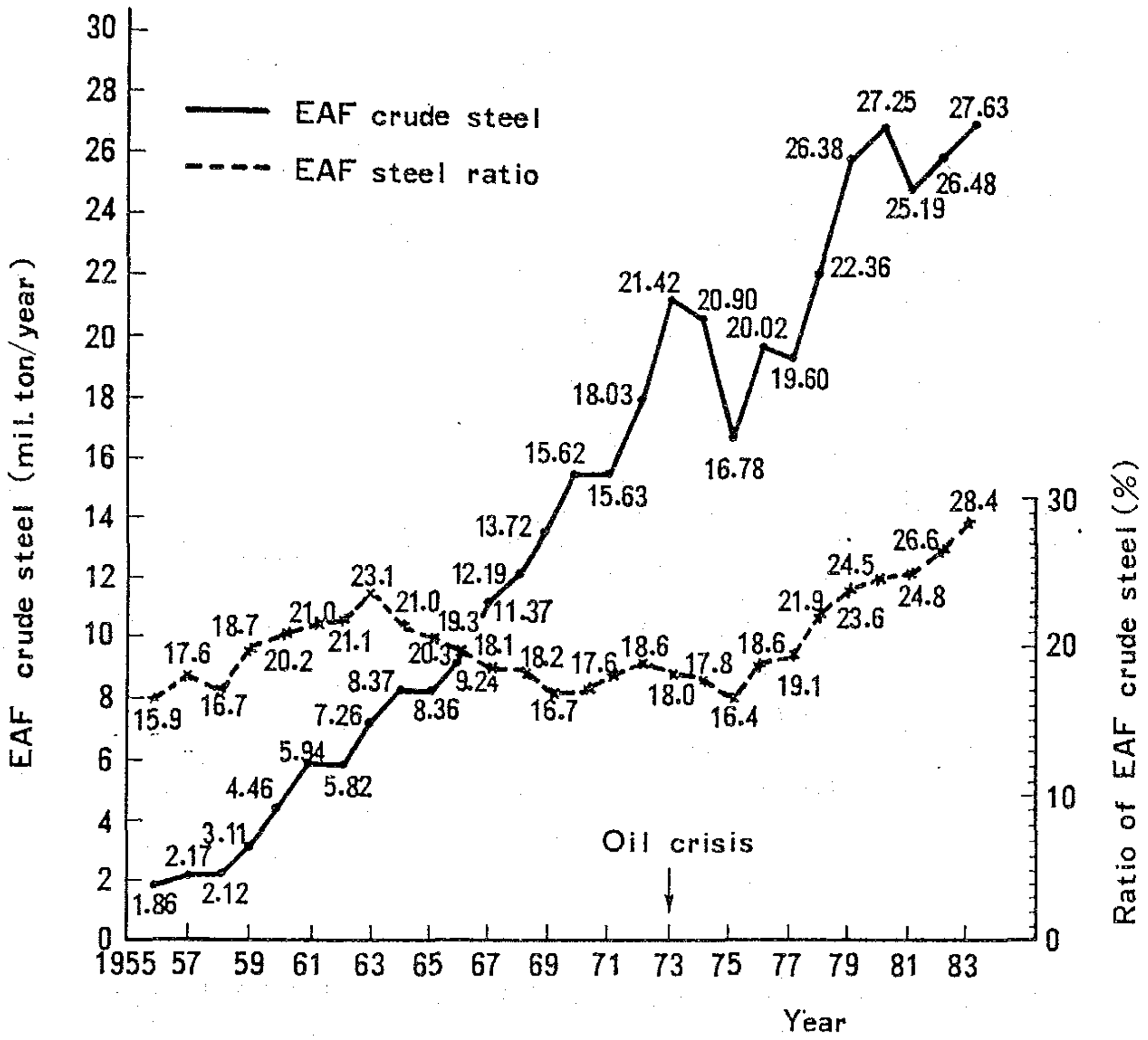


Fig-1 Growth of EAF crude steel and the ratio to total steel production in Japan

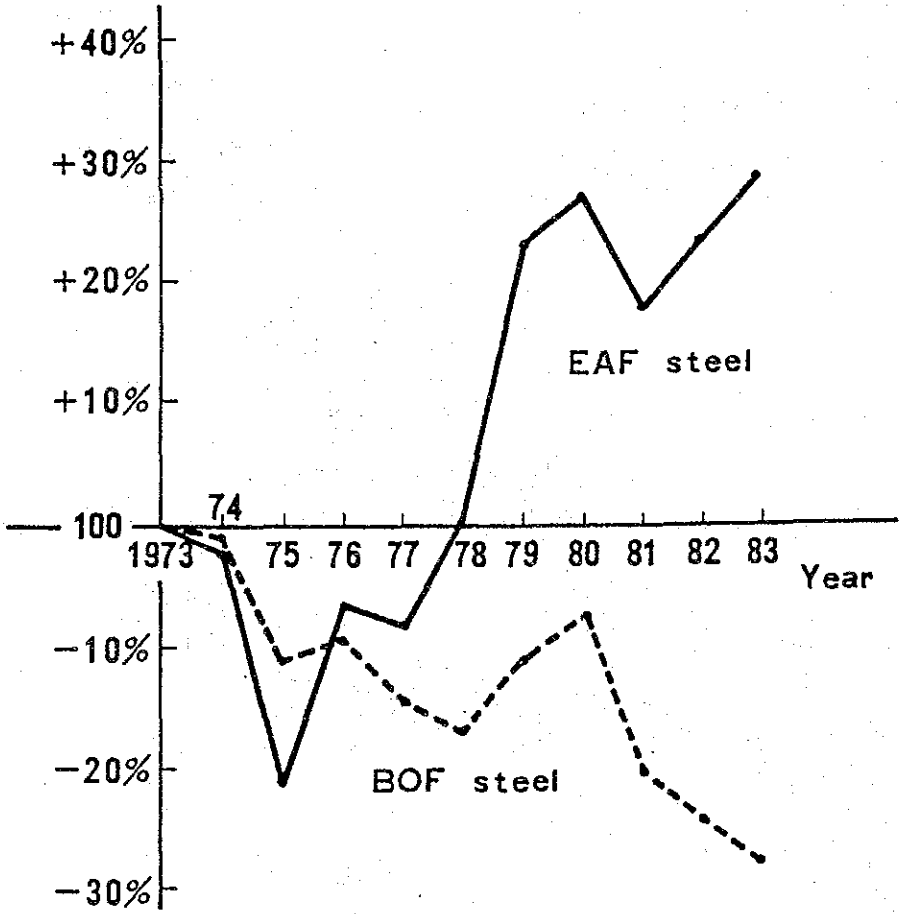


Fig-2 Growth of EAF and BOF crude steel (production in 1973=100) Acoording to statistics by Japan Iron and Steel Federation (JISF)

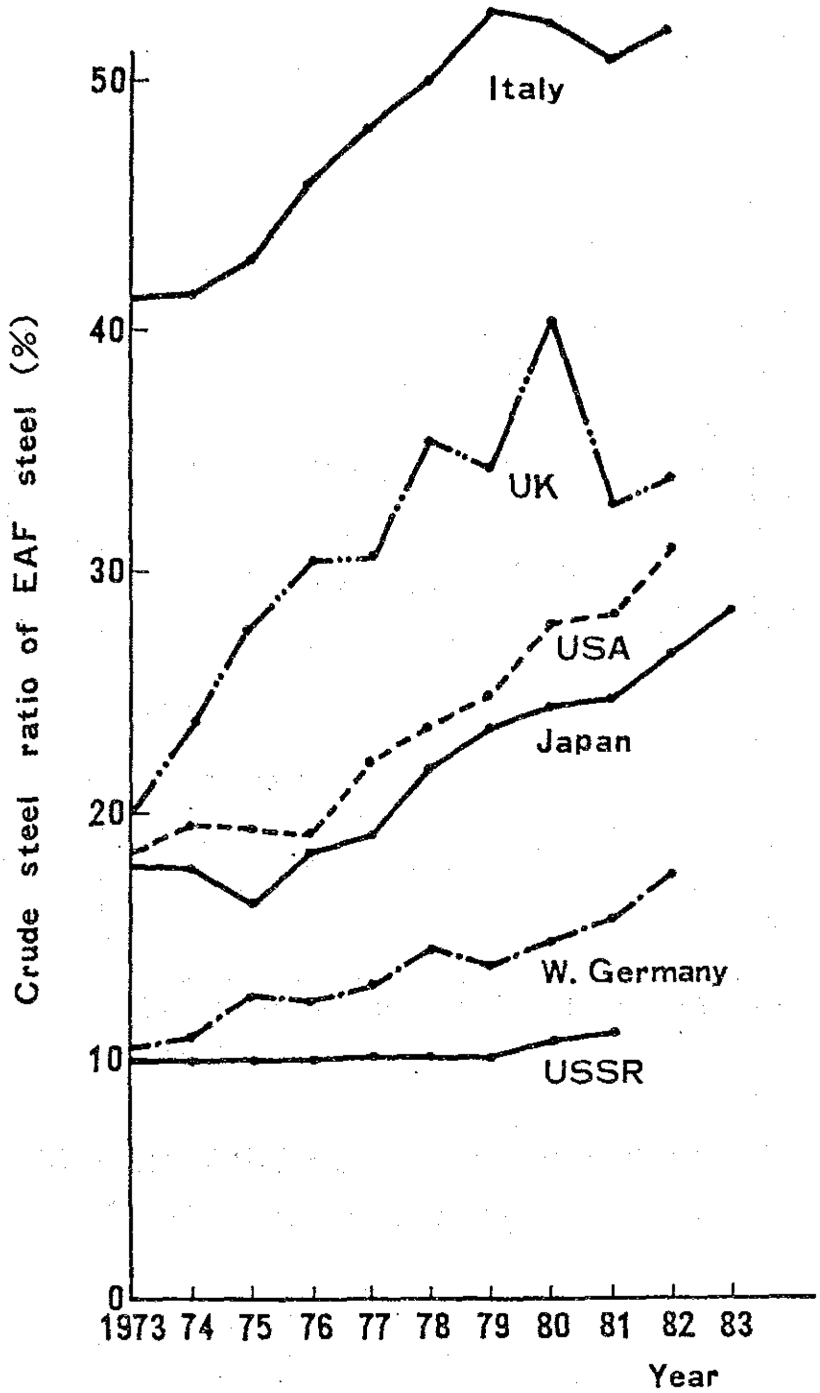


Fig-3 Yearly percentages of EAF steel to total crude steel production in major steelmaking countries (JISF)

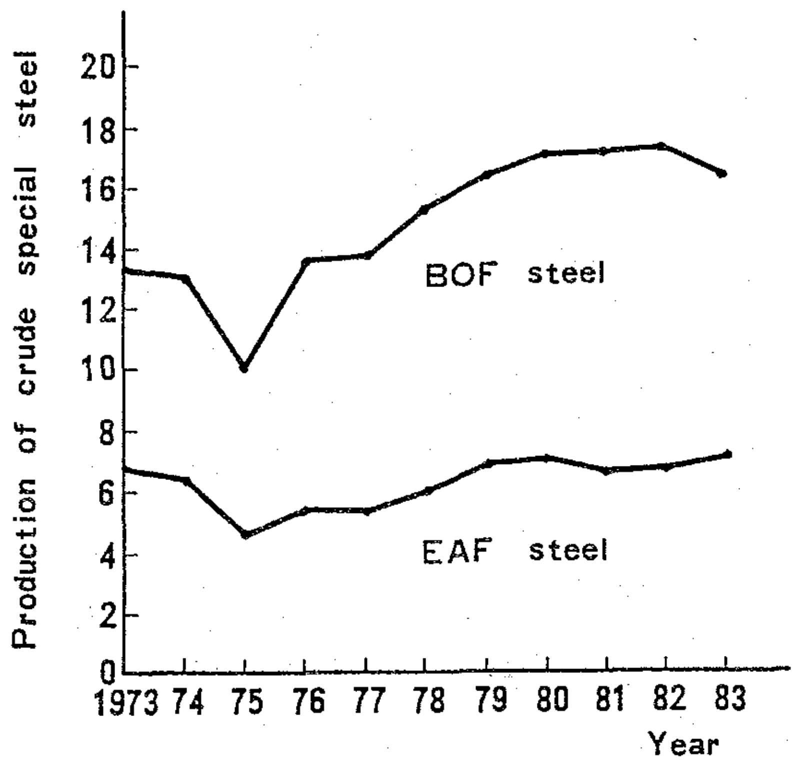


Fig-4 Furnacewise classification of crude special steel (JISF)

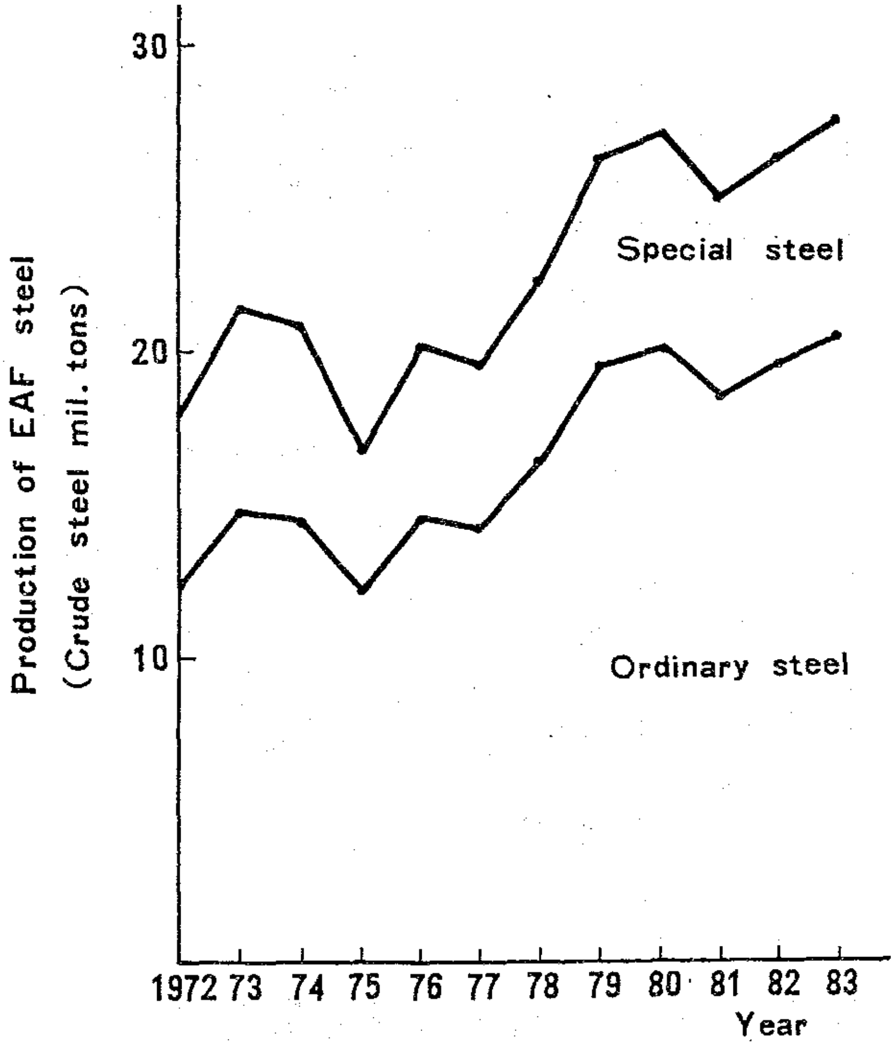


Fig-5 Change of EAF steel production and the steel grade (JISF)

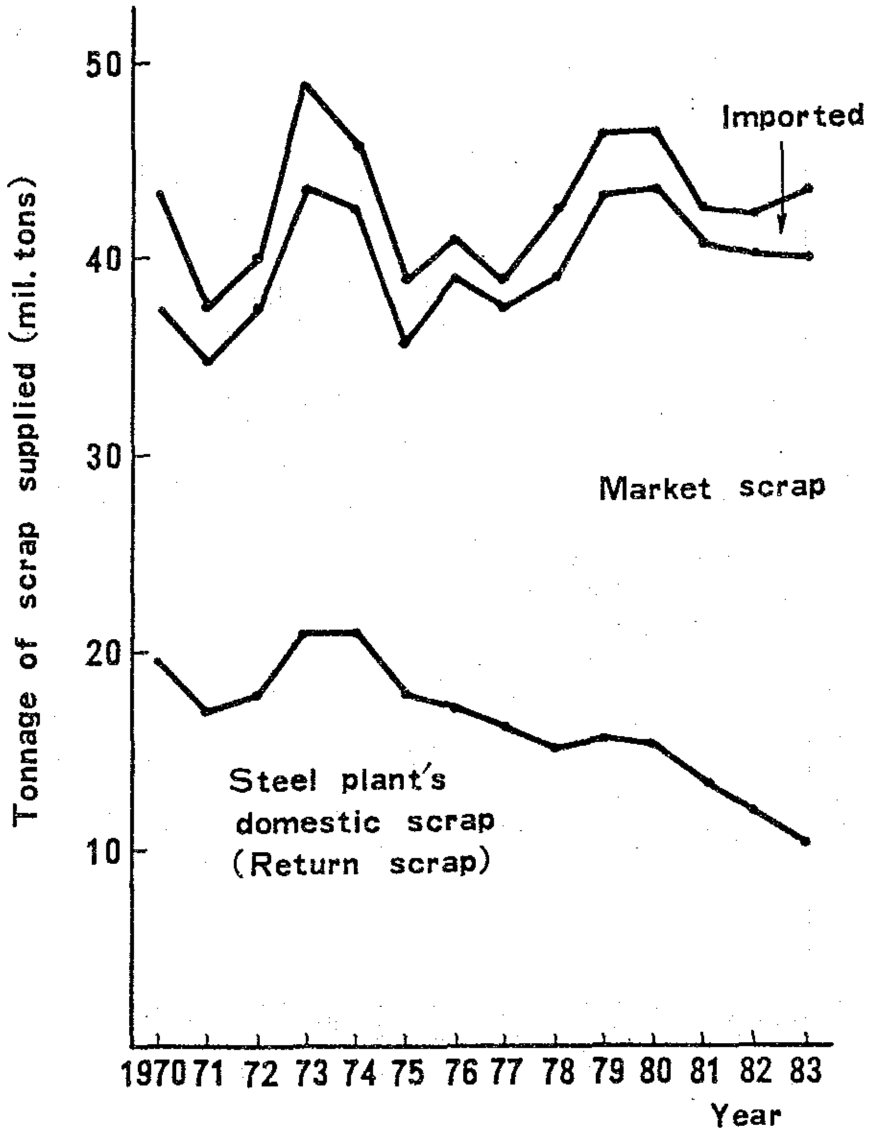


Fig-6 Supply of steelmaking scrap in Japan (JISF)

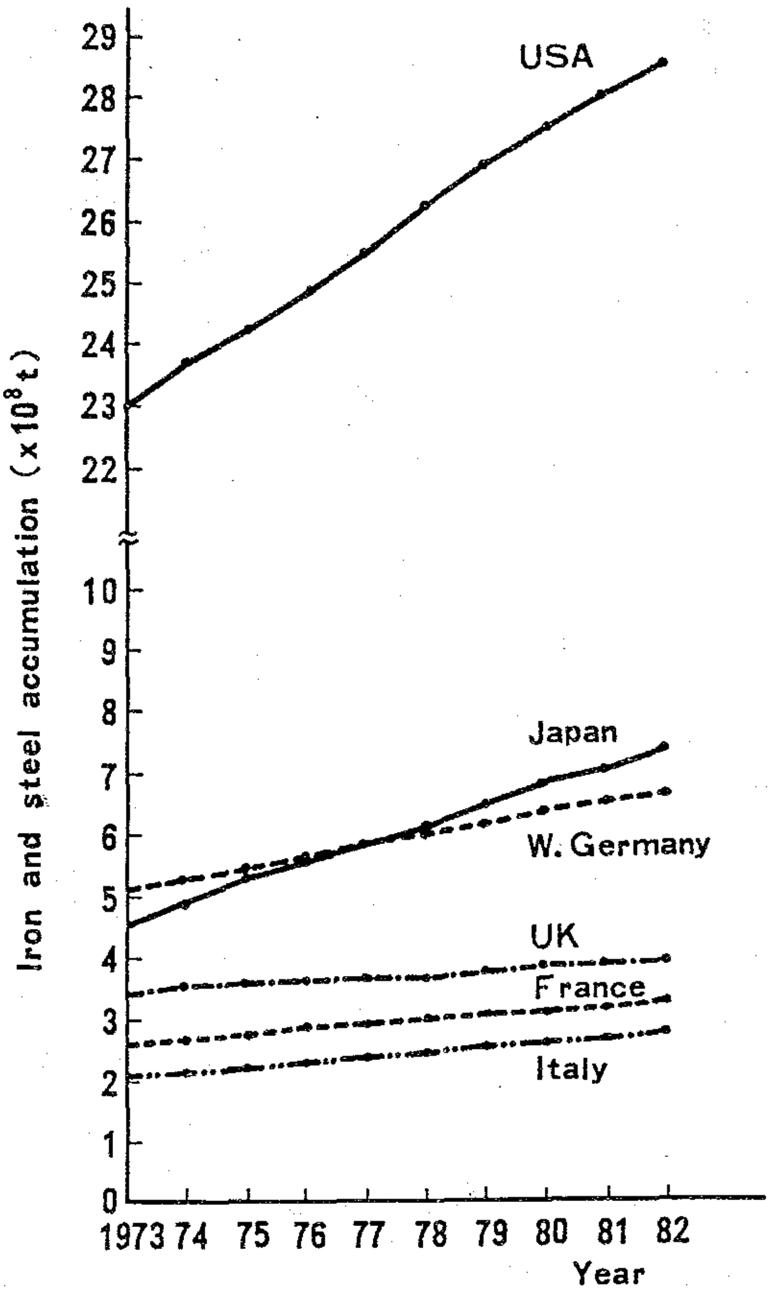


Fig-7 The change in accumulated amount of iron and steel in major steelmaking (JISF)

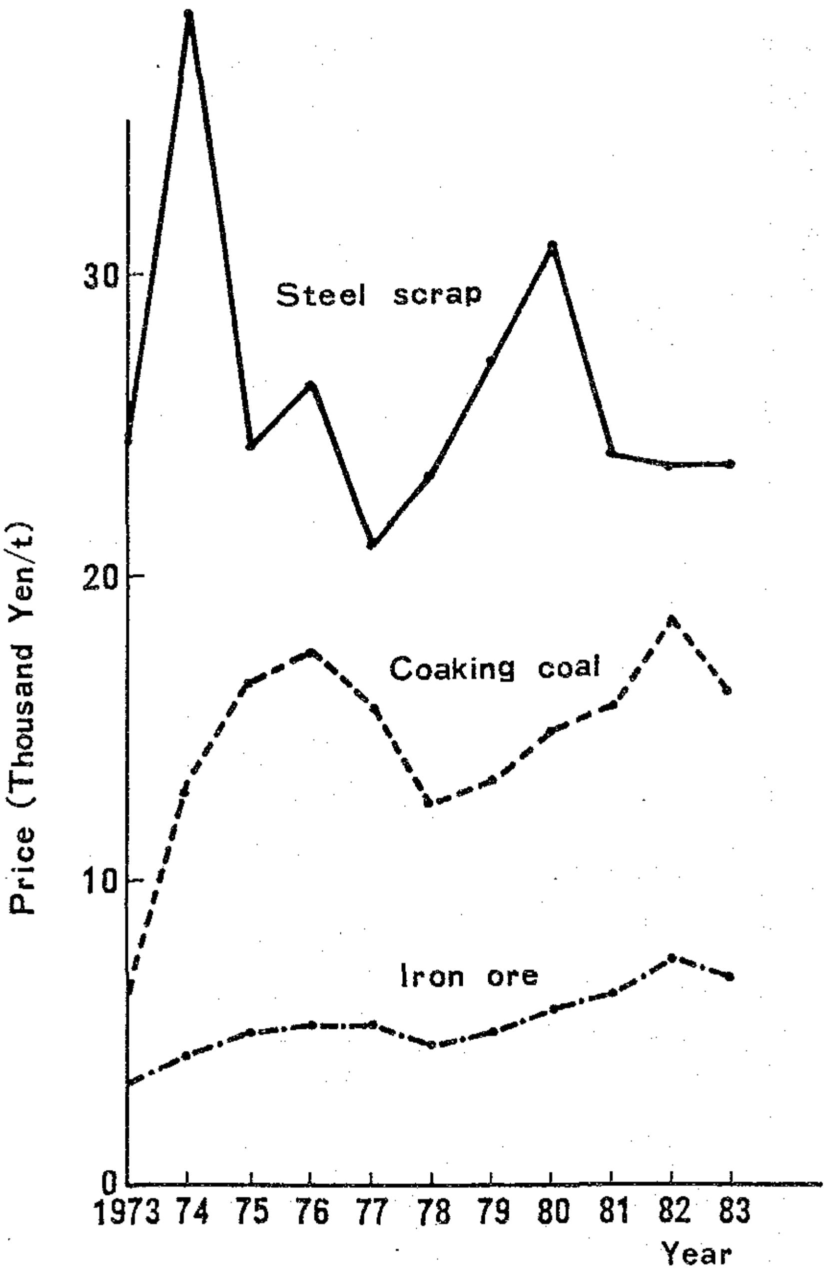


Fig-8 Comparison of prices after oil crisis between scrap, iron ore and coaking coal (JISF)

Table-1 Progress of the steelmaking operation by EAF and the equipment involved

	Furnace design and auxiliary equipment	EAF Operation/Refining and ingotmaking	Tap to tap time (min)	Power consumption (kWh/t)	Remarks
1945	Side charging (Open hearth type); (Electrode control) Balance relay → Amplidyne	Ore steelmaking, Ingot/Top pouring	360 − 480	Up to 800	Bath analysis/chemical (titration) method
	Top charging	Oxygen steelmaking			
1955	Induction stirring	O_2 refining of high Cr−steel	240	650	Instrumental analysis (Emission spectroscopic)
		Degassing (Vacuum casting)			
	Use of larger capacity (over 30t)				
		→ Bottom pouring			Direct suction for dust collecting
	Water cooled panel				
		RH degassing	180	550	
1965	→ Thylister	Sliding nozzle			Fluorescent X−ray analysis
	Oxy fuel burner				
	Application of UHP				
		Stainless steel refining (AOD/VOD)			
Oil crisis		→ Ordinary steel by CC	120	500	Application of computer for analysis
1975		Oxygen enrichment melting			Building dust collection, Power demand control
	Water cooled roof	Carbon injection, Refining by LF	90	450	
	Scrap preheating	→ Special steel by CC			J−comp (Prediction of hardenability)
	Vacuum slag cleaner	Combined steelmaking line	70	420	Enclosing dust collection (sky house)
1985					

Table-2 Installations of existing EAF in Japan by year and capacity (JISF)

Year			1949 or before	1950 – 1954	1955 – 1959	1960 – 1964	1965 – 1969	1970 – 1974	1975 – 1979	1980 –	Total
Whole situation	Furnace capacity	Up to 9t	55	9	15	33	34	23	10	–	179
		10 to 15	14	4	11	12	7	5	2	–	55
		20 to 25	3	1	3	7	6	16	–	1	37
		30 to 45	–	–	8	19	7	21	7	–	62
		50 to 60	–	–	–	10	5	27	5	2	49
		70 to 80	–	–	–	4	4	5	2	2	17
		90 to 100	–	–	–	1	–	2	3	2	8
		Over 110t	–	–	–	1 (200t)	1 (120t)	1 (120t)	3 (150t, 140t x 2)	–	6
		Total (units)	72	14	37	87	64	100	32	7	413
		Average capacity (t)	6.7	8.0	13.7	25.7	20.3	34.0	45.8	67.9	24.2
Increase of big furnace and change to high power	≥30t Furnace	Number of installations			8	35	17	56	20	6	142
		Average f'ce capacity (A) (t)			31.9	50.6	54.7	51.3	69.0	75.0	53.9
		Average transformer capacity (B) (MVA)			12.8	20.9	22.3	26.4	35.0	56.7	26.1
		Furnace vs transformer (B/A) (MVA/t)			0.401	0.413	0.407	0.515	0.507	0.756	0.484

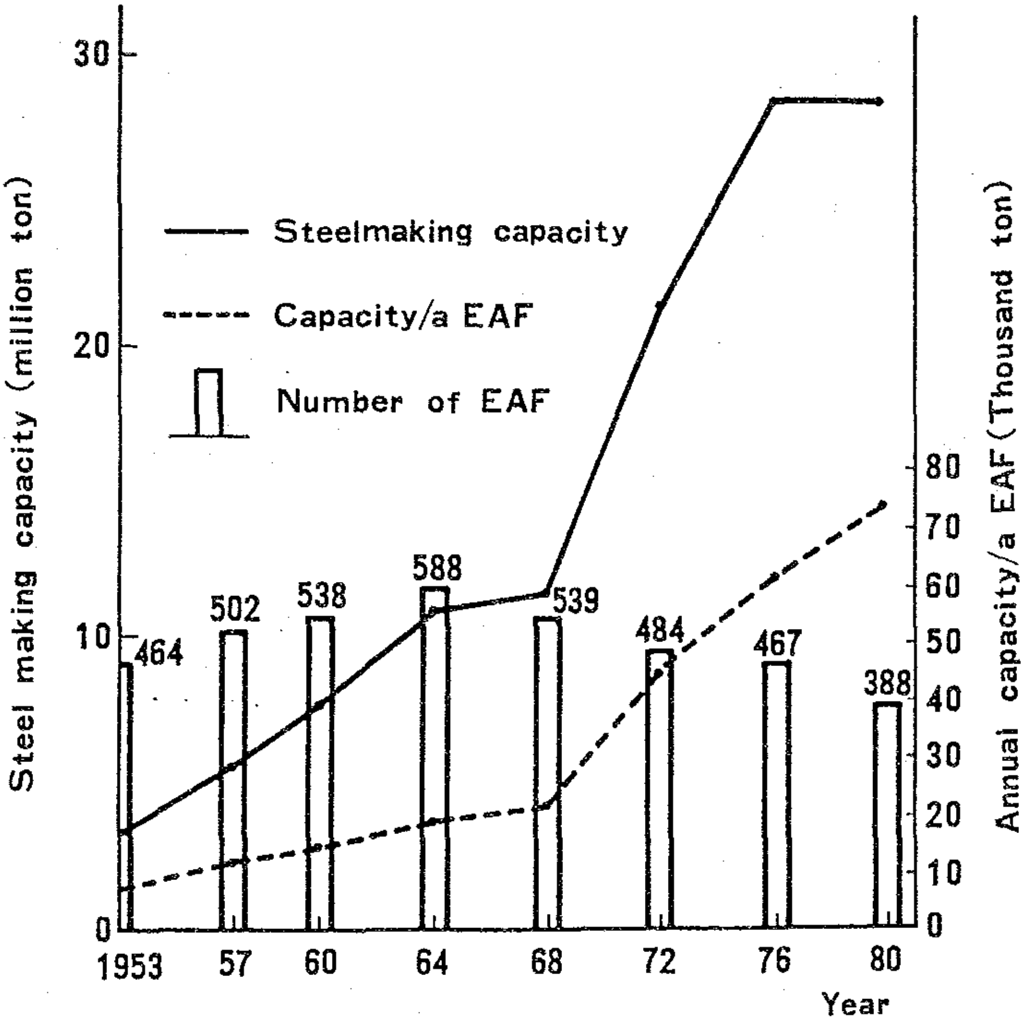
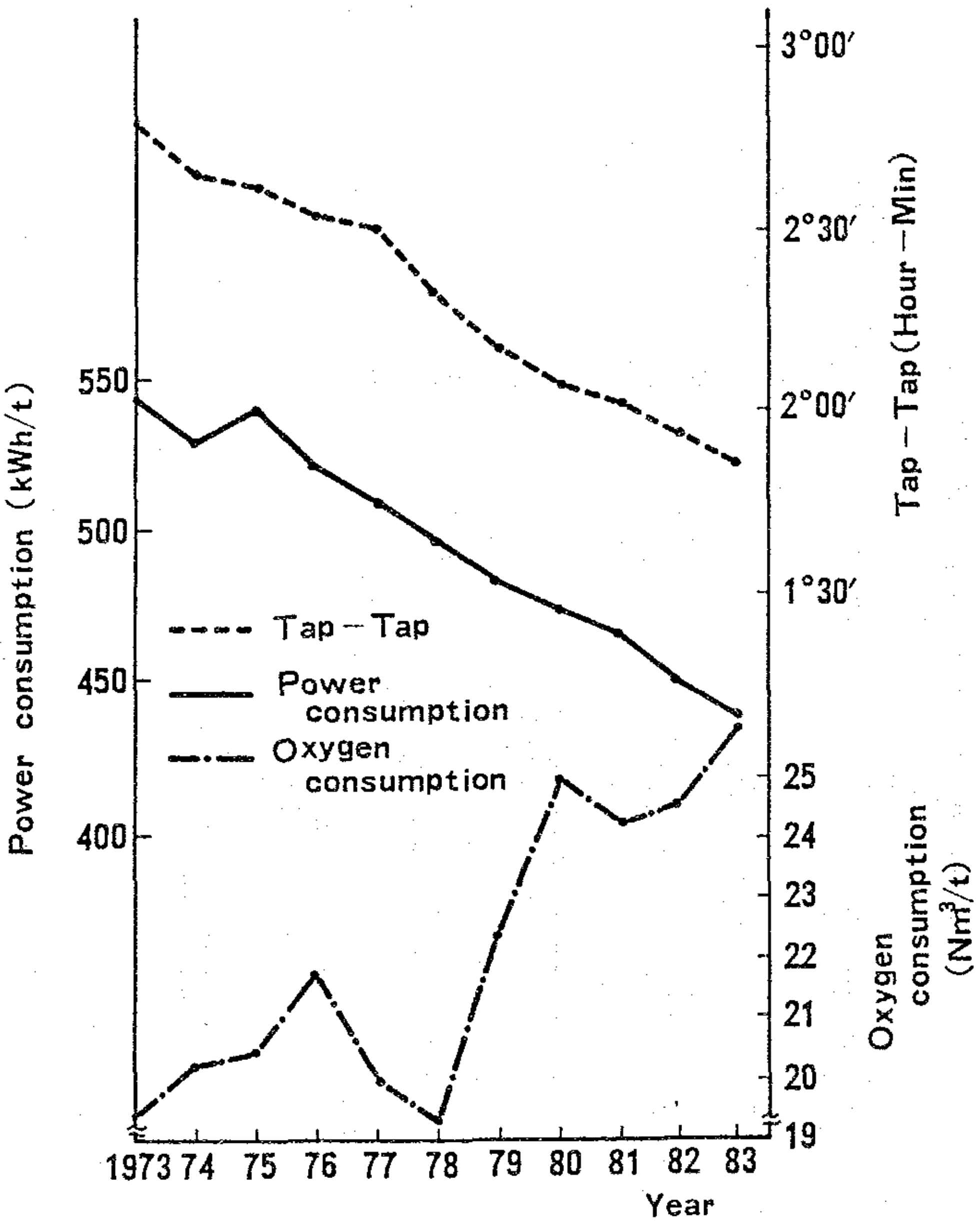


Fig-9 Change of production capacity and number of EAF in Japan (JISF)



Fig−10 Change of steelmaking time, power and oxygen consumption in EAF

(Average value of 146 furnaces in member companies of JISF)

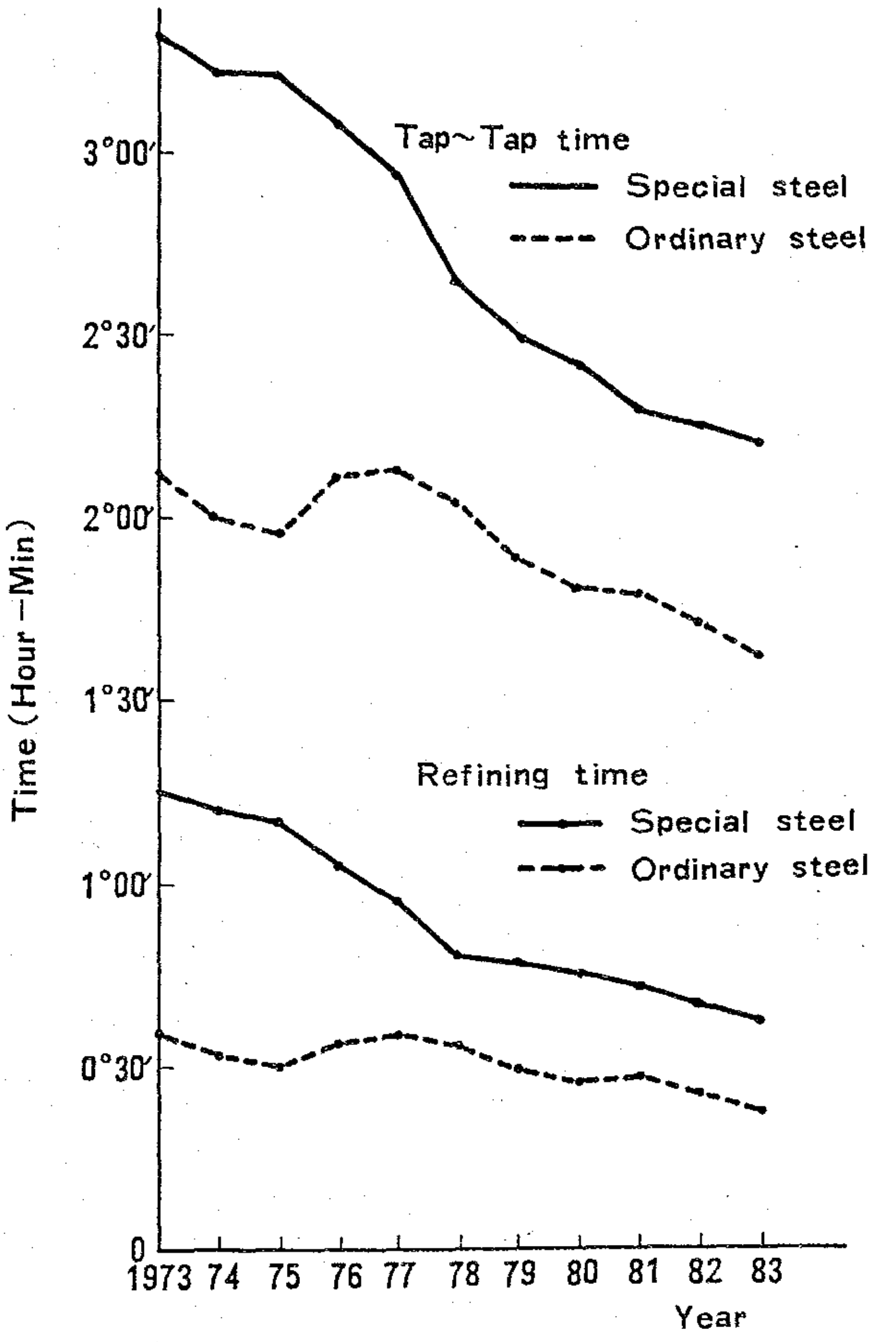


Fig-11 Change of steelmaking time (Tap-Tap time) and refining time in EAF (JISF)

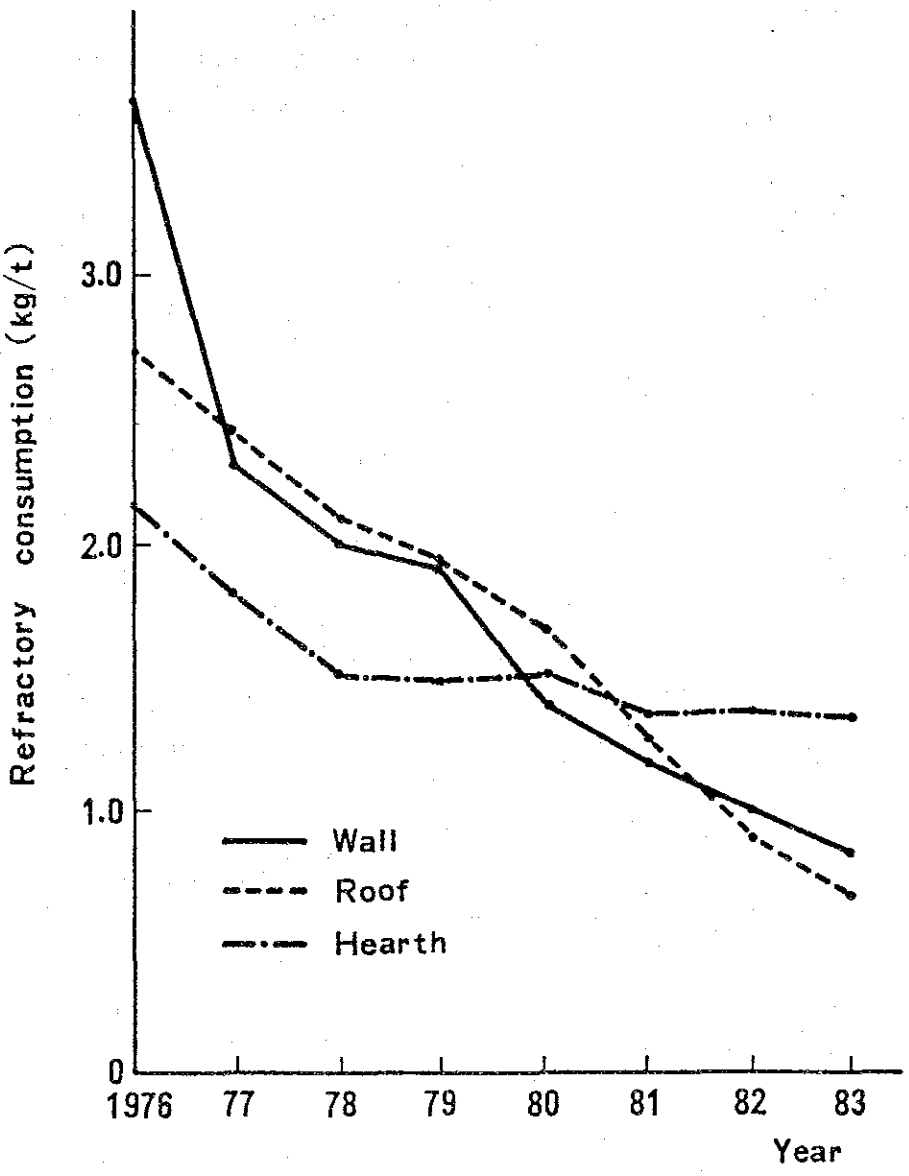


Fig-12 Change of refractory consumption in EAF (JISF)

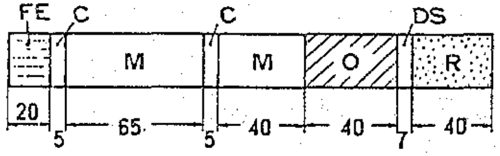
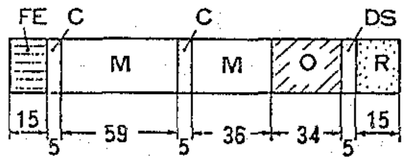
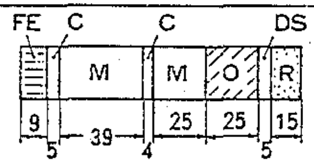
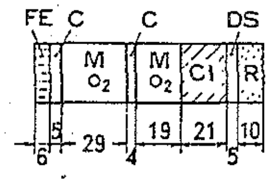
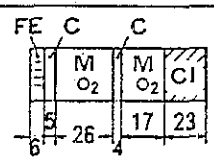
PERIOD	EVENTS	MELTING PATTERN (min)	F'CE x UNITS TRANSFORMER	TAP TO TAP(min)	POWER CON-SUMP-TION (kWh/t)	PRODUCTIVITY (by 70t f'ce) (t/h)
First (I) ('62-'65)	Dawn of operation of larger EAF · Still in conventional refining method		70t x 2 50t x 1 22 MVA x 2 20 MVA x 1	222	564	16.6
Second (II) ('66-'70)	Establishment of larger furnace operation technology · Introduction of RH · Decreased reduction period		70t x 3 50t x 1 22 MVA x 2 20 MVA x 2	172	563	22.0
Third (III) ('71-'75)	Improved productivity by application of UHP · Increased application of ladle refining · Application of WCP		70t x 4 50t x 1 45 MVA x 2 35, 32MVA 20 MVA	125	550	34.5
Forth (IV) ('76-'81)	New development of operation technology · Oxygen enrichment plus carbon injection · Rapid operation determined by heating rate		70t x 4 45 MVA x 2 35 MVA 32 MVA	99	425	50.0
Fifth (V) ('81-'84)	Establishment of new steelmaking line · EAF-LF-RH-CC(ELVAC) · Stable application of sequence casting		70t x 4 45 MVA x 2 35 MVA 32 MVA	81	407	61.1

Fig-13 Changes in the operation technology of EAF at Chita Plant (Daido)

Note) FE : Fettling C : Charging M : Melting O : Oxidization DS : Deslagging
R : Reduction CI : Carbon injection and heating-up

Table-3 Quantitative effects of power reduction (Reduction at the level of about 500kWh/t)

Means of reduction	Quantitative effects	
High power application	28kWh/t	Increase of power source capacity per 100kW/t
Reduced tap to tap time	20kWh/t	Reduction of time per 10min
Operation with oxygen enrichment	44kWh/t	Increased oxygen consumption per $10Nm^3/t$
Scrap preheating	40kWh/t	Preheated up to 300−400℃

(From IISI SCE data)

Table-4 Installation of secondary refining for EAF in Japan (As of 1983)

Process	DH	RH	LD*	LF	ASEA -SKF	VAD	VOD	AOD
Units	3	6	14	21	3	2	8	13

*Ladle degassing in vacuum tank

Table-5 EAF steel tonnage treated by different secondary refinings

Unit: good ingnt ton X 1000 (in 1983)

Refining	V (LD)	DH	RH	LF-V	LF-RH	LF	ASEA	VAD	VOD	AOD	Total	EAF crude steel	Ratio of secondary refining (%)
Annual tonnage treated ($x10^3$)	417	30	882	487	1640	2004	166	143	143	762	6674	27629	24.2
				LF total : 4131				Ordinary steel :			1175	20539	5.7
			RH total : 2522					Special steel :			5499	7090	77.5
	V(LD) total : 904												

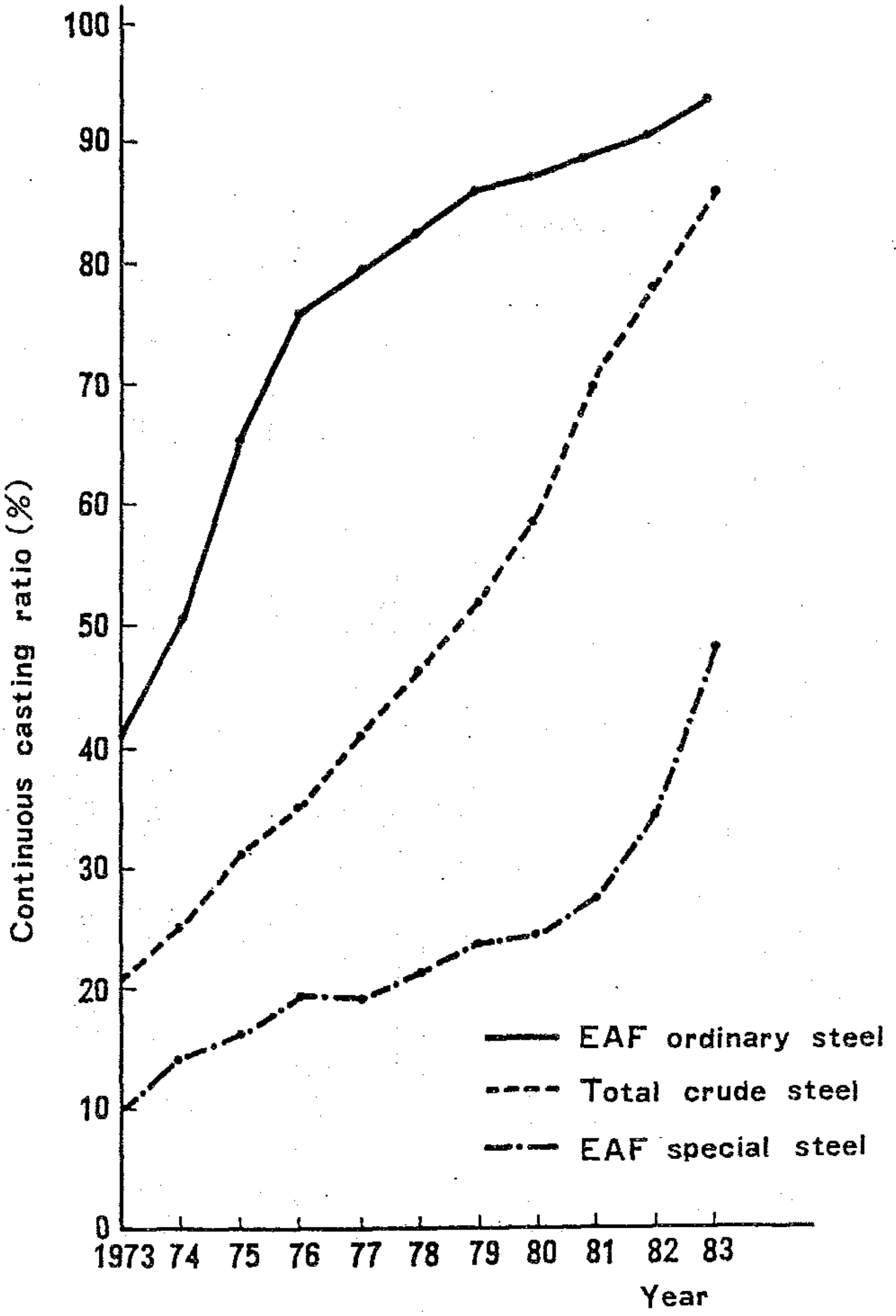


Fig-14 Change of continuous casting ratio in EAF (JISF)

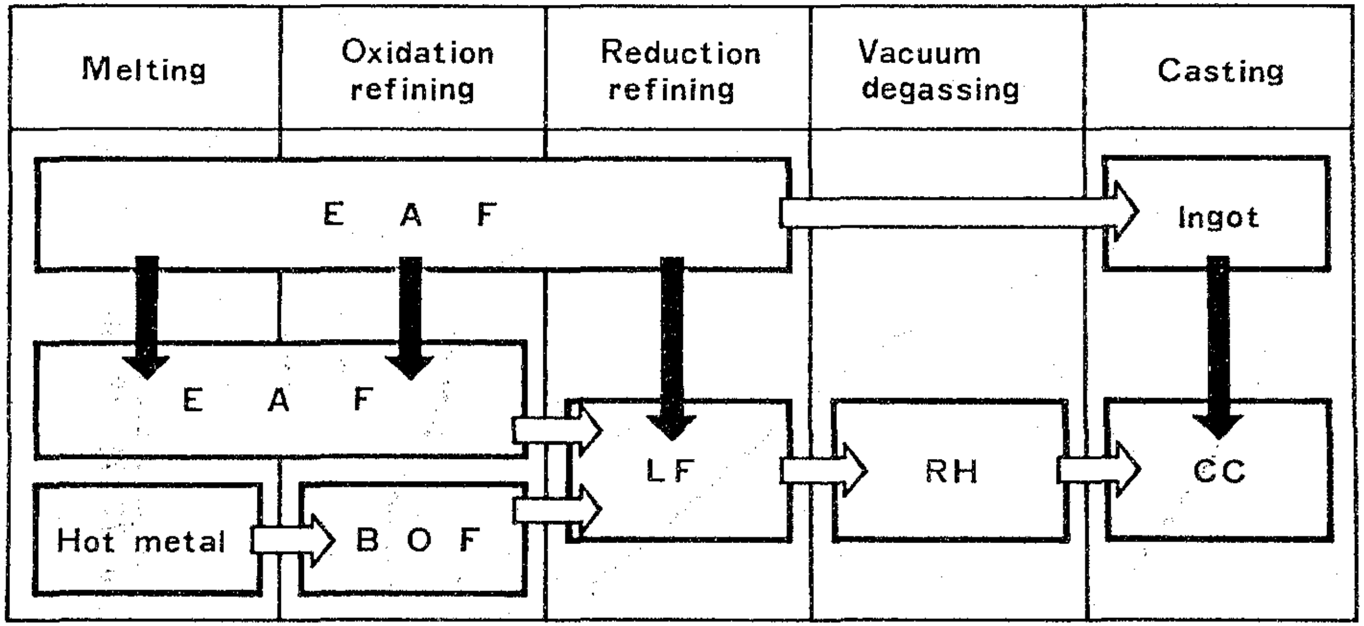


Fig-15 Development of steelmaking process of high grade steels

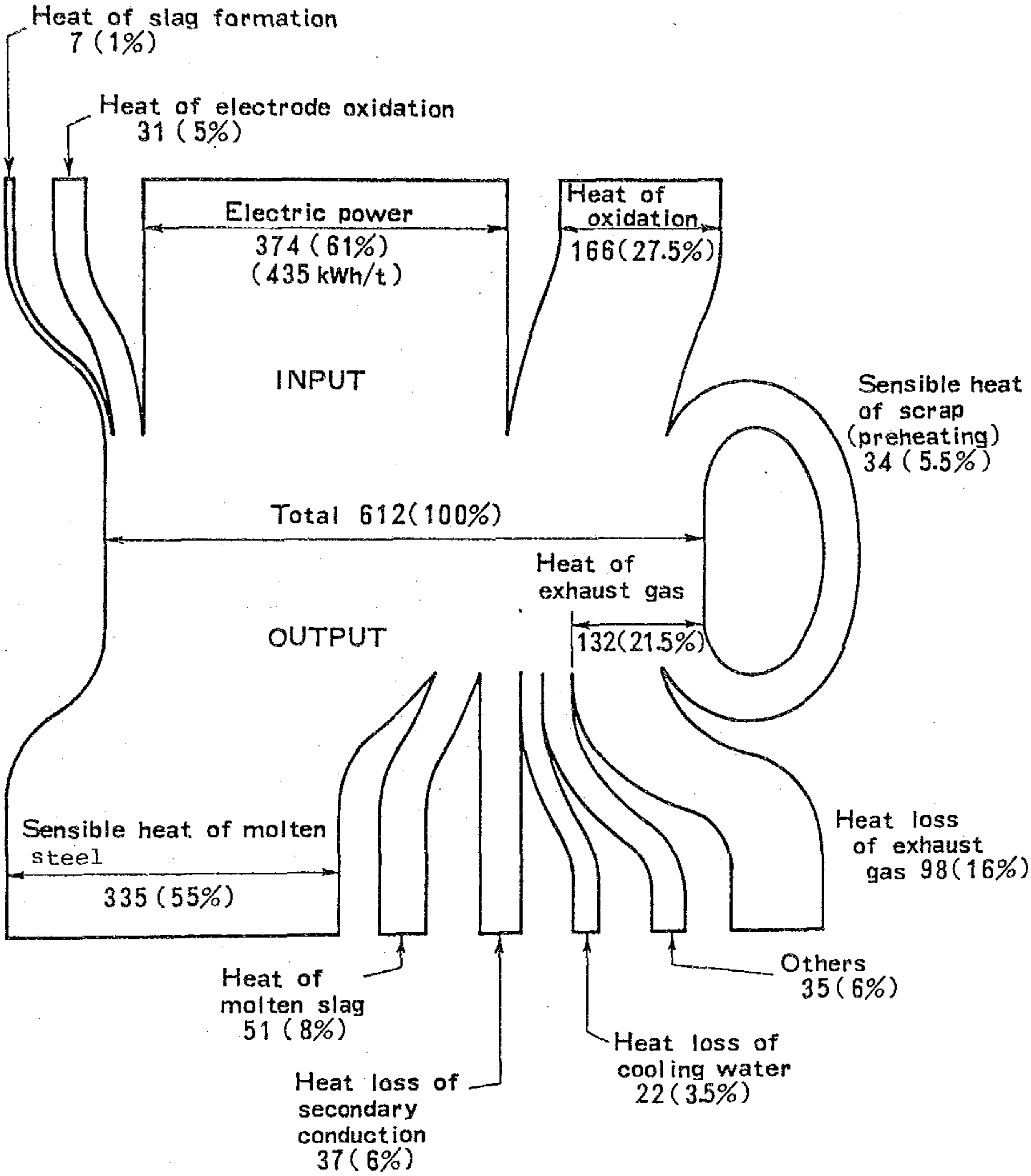


Fig-16 Heat balance of 25t EAF with scrap preheater (Mcal/t)

Continuous Casting

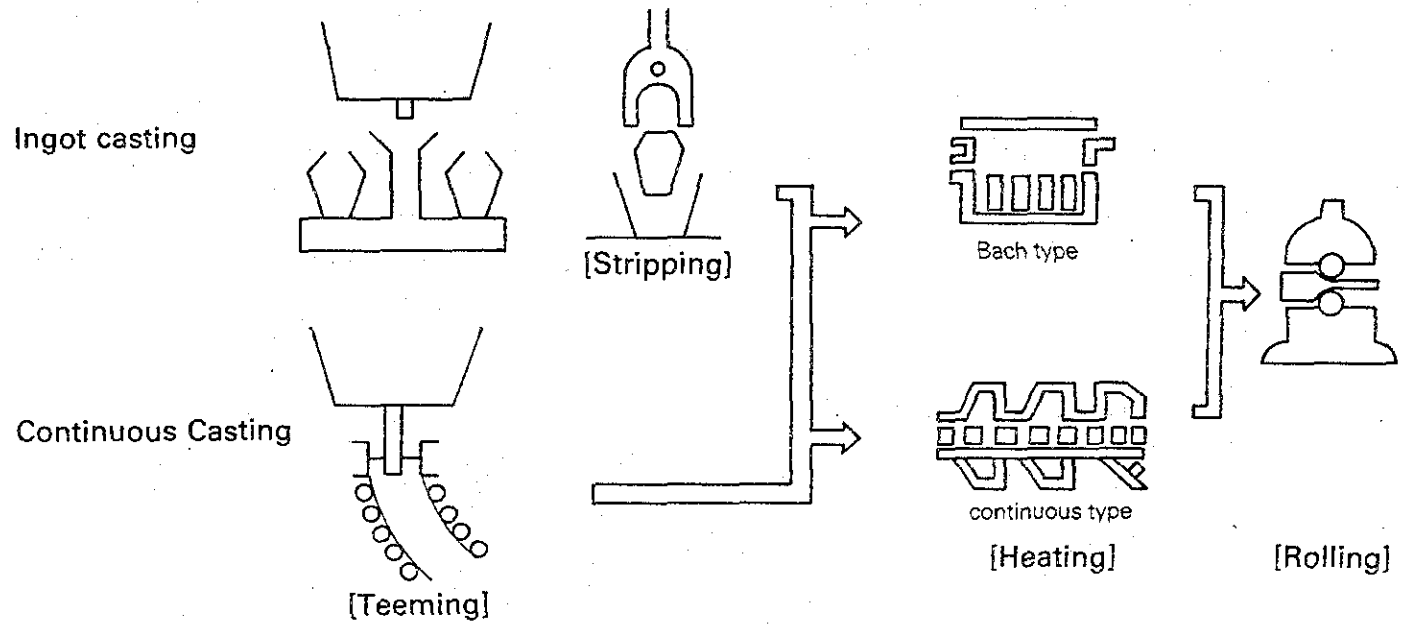
Ryuzo Komatsu

AICHI STEEL WORKS, LTD.

Japan

(1)

1. Ingot casting and Continuous Casting



Advantages of continuous casting

(1) Cost reduction by improvement of yield and energy saving
(2) Automation and labor saving
(3) Improvement of environment

(2)

2 Type of continuous caster

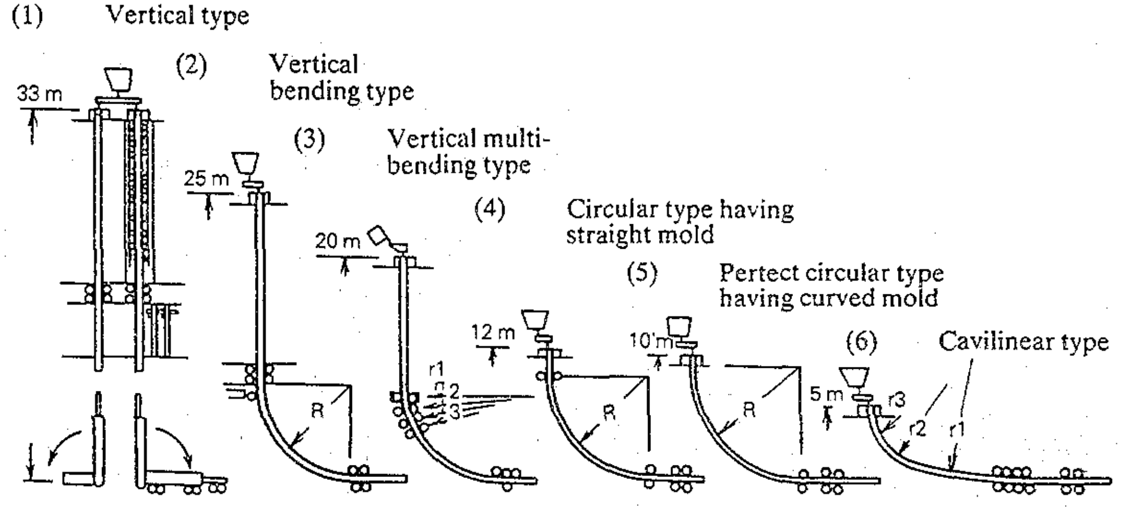


Fig. 1

In the 1950's, vertical type was mainly installed
In the 1960's, the type was switched over to the bending type.

	disadvantage	advantage
vertical type	● tall in the height of equipment ● expensive	● effective for floating Inclusion ● no straightner → no traverse crack

(3)

3. Recent trend of continuous casting

3.1 Total crude steel in Japan and ratio of continious casting in Japan, USA, Europe.

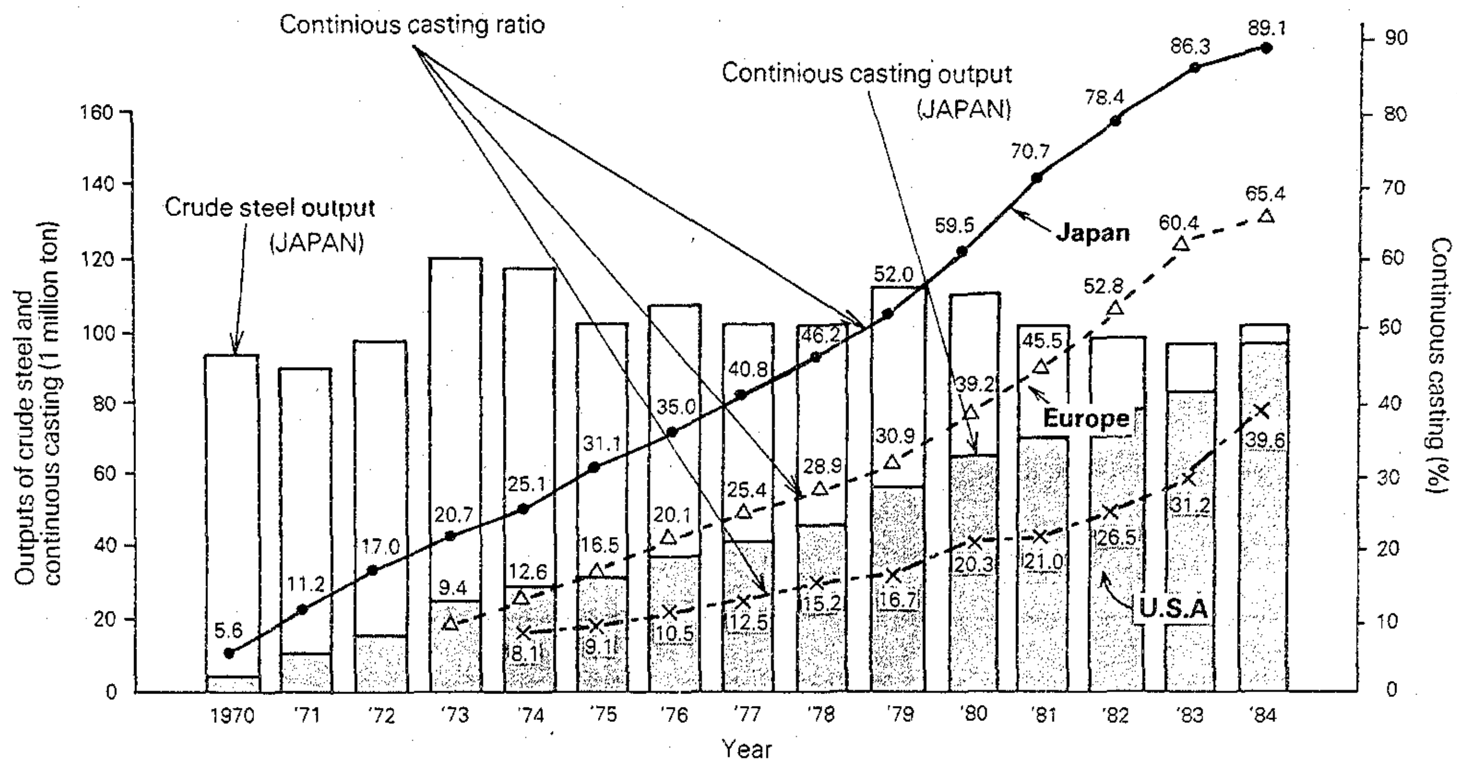


Fig. 2

(4)

3.2 Continuous casting in the field of electric steel making

The strand is mainly produced for bloom and billet.

Bloom : more than 180 $^{mm \cdot S}$ → 2 heats

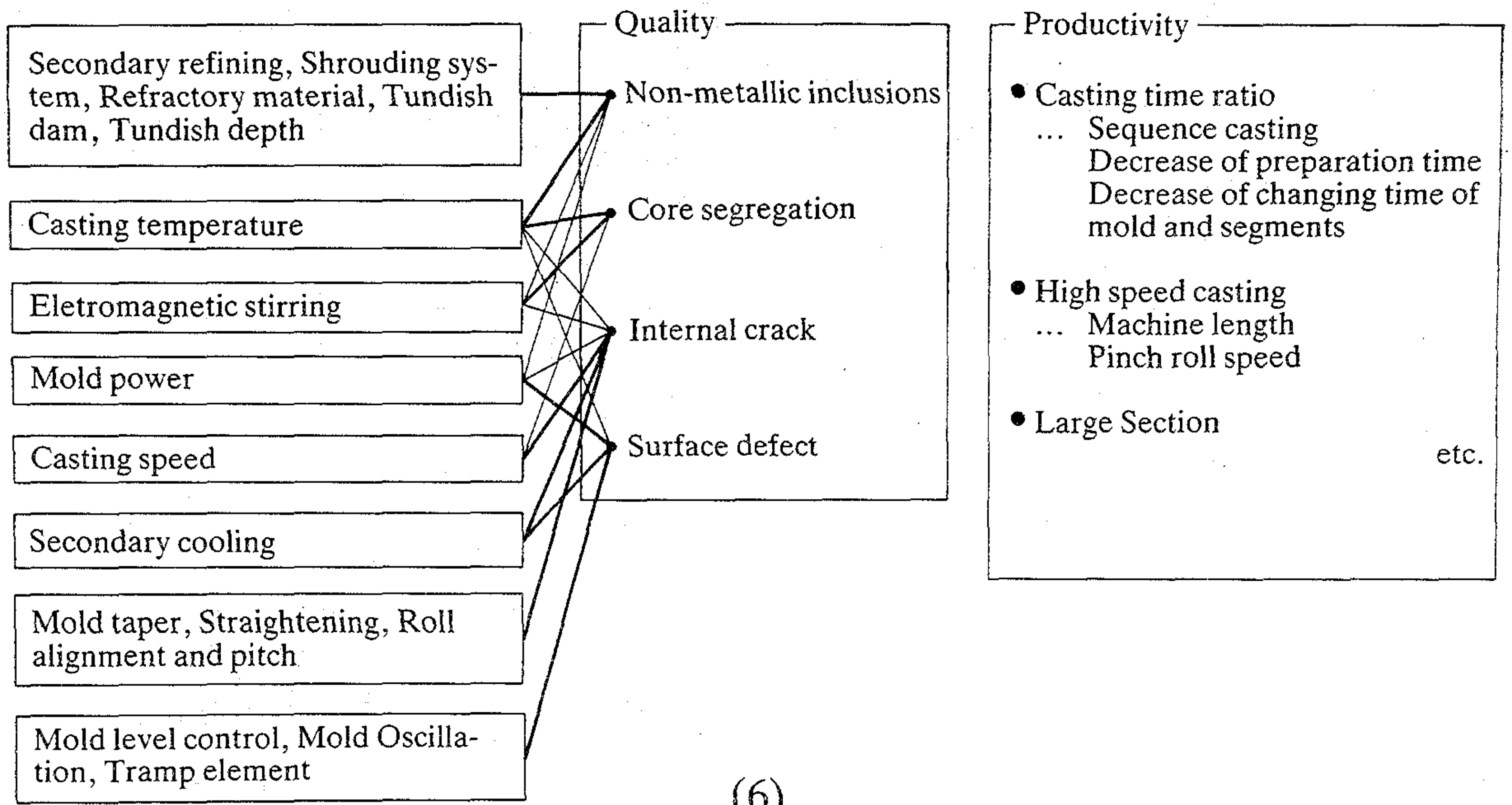
Billet : less than 180 $^{mm \cdot S}$ → 1 heat

Shape	Steel grade	Application ratio
Bar and Wire rod	Ordinary steel	Almost 100 %
	Special steel (stainless steel)	Almost 90 %
	Special steel (Mass produced special steel mainly for automotive uses)	Almost 60 % (Mainly blooming process)
Plate	Stainless steel	Almost 100 %

(5)

4 Bloom and billet continuous casting techniques

4.1 Quality control and Productivity improvement technique



(6)

4.2 Quality control

4.2.1 Non metallic inclusion

(1) Purification of molten steel
Secondary refining such as LF and RH
(2) Prevention of reoxdation of molten steel

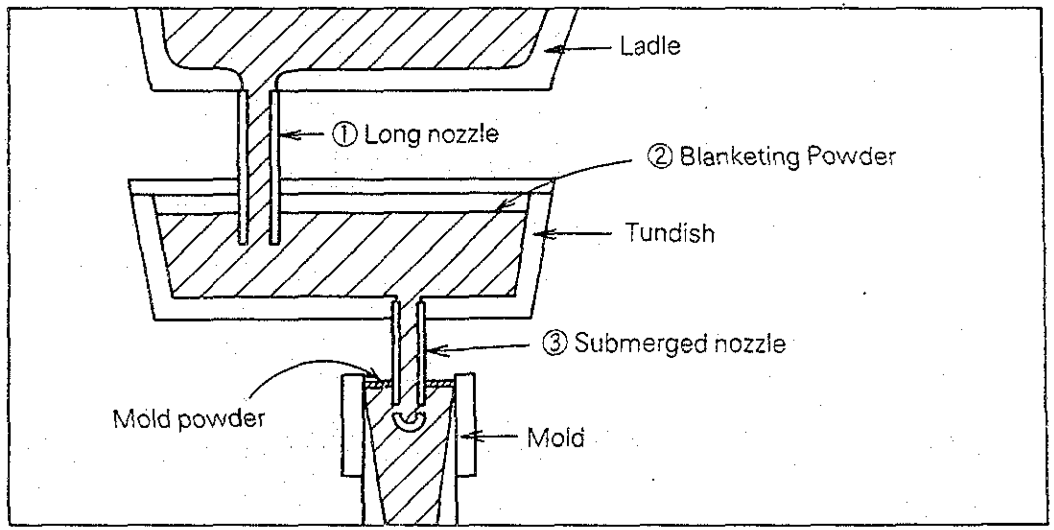


Fig. 3 An example for prevention of reoxdation of molten steel

(7)

(3) Consideration of tundish

① Use of large size tundish
especially the increase of molten steel depth – Fig. 4.5 –

② Providing dams in Tundish – Fig. 4 –

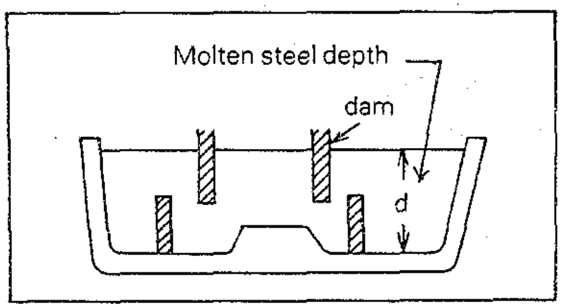


Fig. 4 An example for kind of dam

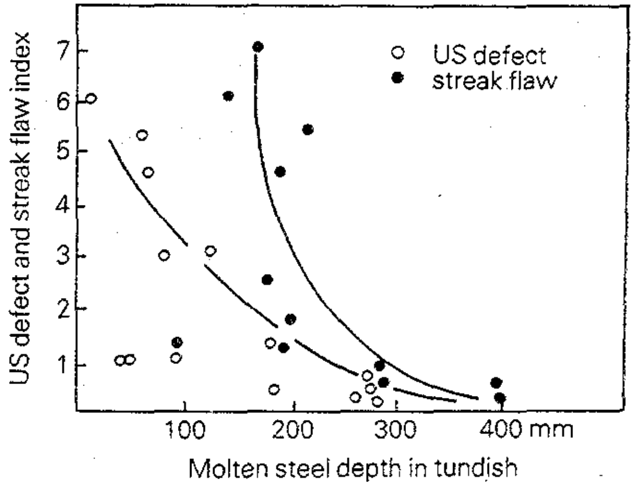


Fig. 5 Relation between molten steel depth in tundish and US defect and streak flaw

③ Refractory in tundish

(8)

④ Floating of inclusions in the mold
especially the consideration of discharge hole diameter and shape of submerged nozzle

⑤ Casting temperature control

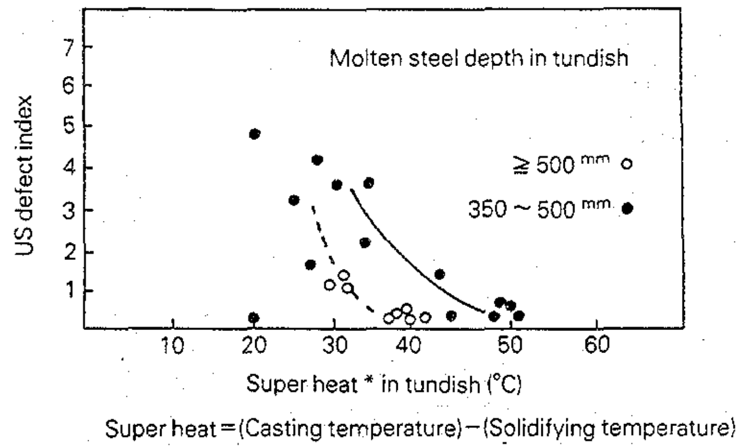


Fig. 6 Relation between super heat in tundish and U.S. defect occurrence

(9)

4.2.2 Core segregation

(1) Casting temperature control

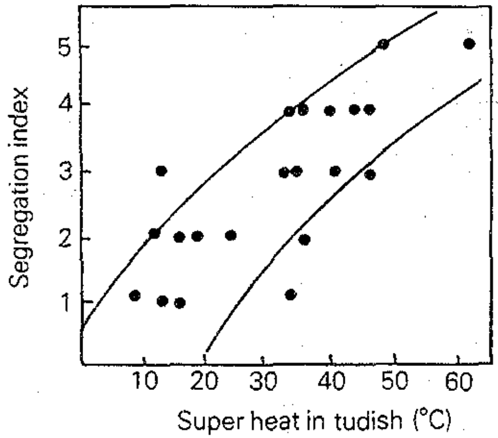


Fig. 7 Relation between super heat and segregation index

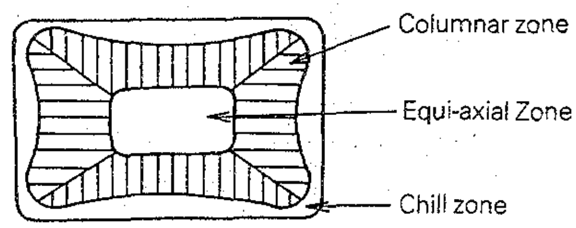


Fig. 8 Solidification structure of strand section.

Low temperature casting widens the equi-axial range and is effective for core segreation

(10)

(2) Electromagnetic stirring

Ⓐ The increase of stirring power improve core segregation.

Ⓑ Powerful stirring power produces white band.

Ⓒ It is neccssary to be an optimum stirring

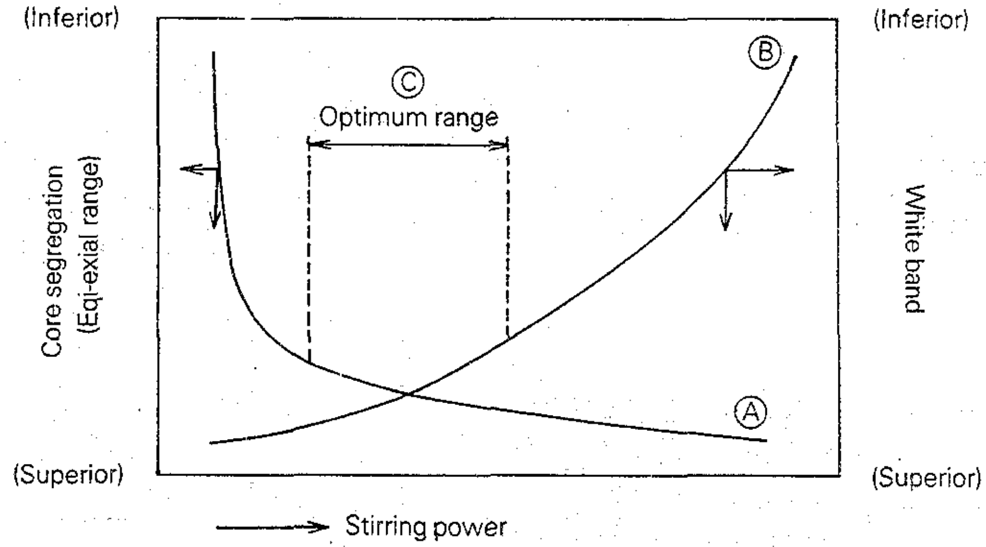
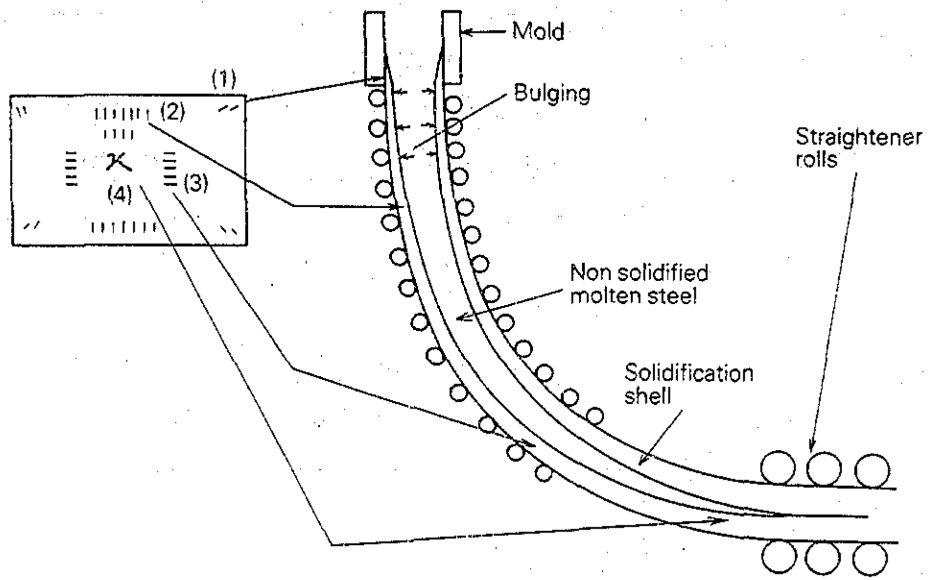


Fig. 8 Relation betweem stirring power and core segregation and white band

(11)

4.2.3 Internal cracks



(1) Corner crack
(2) Tip crack
(3) Intermediate crack
(4) Center crack

Fig. 9 Types of internal cracks and their developing stage

Main prevention of crack

(1)	• Appropriate mold-taper • Good supporting rolls
(2)	• Maintenance of roll alignment • Design of optimum roll pitch • Increasing of machine rigidity • Casting speed and cooling speed control
(3)	• Cooling speed control
(4)	• Multipoint straightening

(12)

4.2.4 Surface defect

(1) Classification of surface defects

Category	Sub-category
① Crack	● Crazing
② Traverse crack	● Corner traverse crack ● Surface traverse crack
③ Longitudinal crack	● Corner longitudinal crack ● Surface longitudinal crack
④ Inclusion pores	● Alumina-Cluster ● Slag inclusion ● Pin hole

(2) Main prevention of surface defects

- ○ Chemical component control (Mn, S, Al, N, Cu, Sn etc)
- ○ Cr or Ni plating on cupper mold
- ○ Mold cooling control
- ○ Mold powder quality
- ○ Improvement of accuracy of molten steel level in the mold
- ○ Mold oscillation
- ○ Secondary cooling control.

(13)

4.3 Productivity improvement techinique

4.3.1 Improvement of casting time ratio

– How to reduce the noncasting time –

Details of noncasting time

Preparation time	Mold and segment changing time	Waiting time for melting and casting	Down time due to accident, trouble	Others

(1) Sequence casting

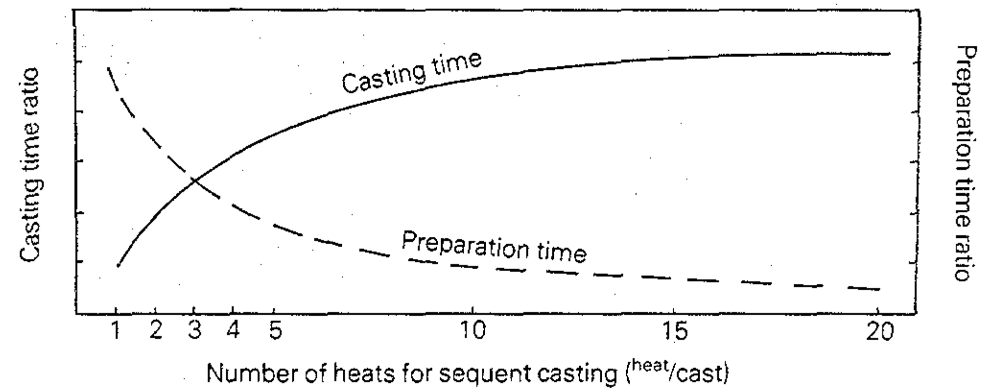


Fig. 10 Relation between number of heats for sequent casting and casting time and preparation time

(14)

A method of Sequent casting

- ○ Flowing of molten steel between same tundishes with same steel type
- ○ Replacing tundishes and connecting the heat and the next heat in the mold – Fig. 11 –

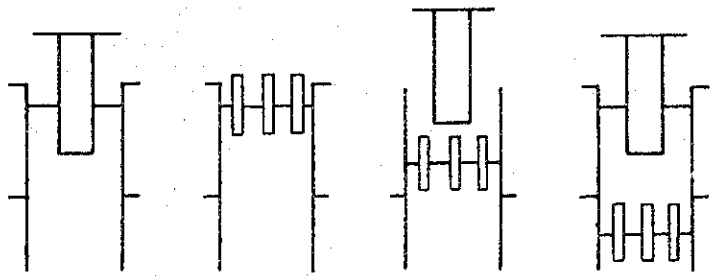


Fig. 11 Joint method

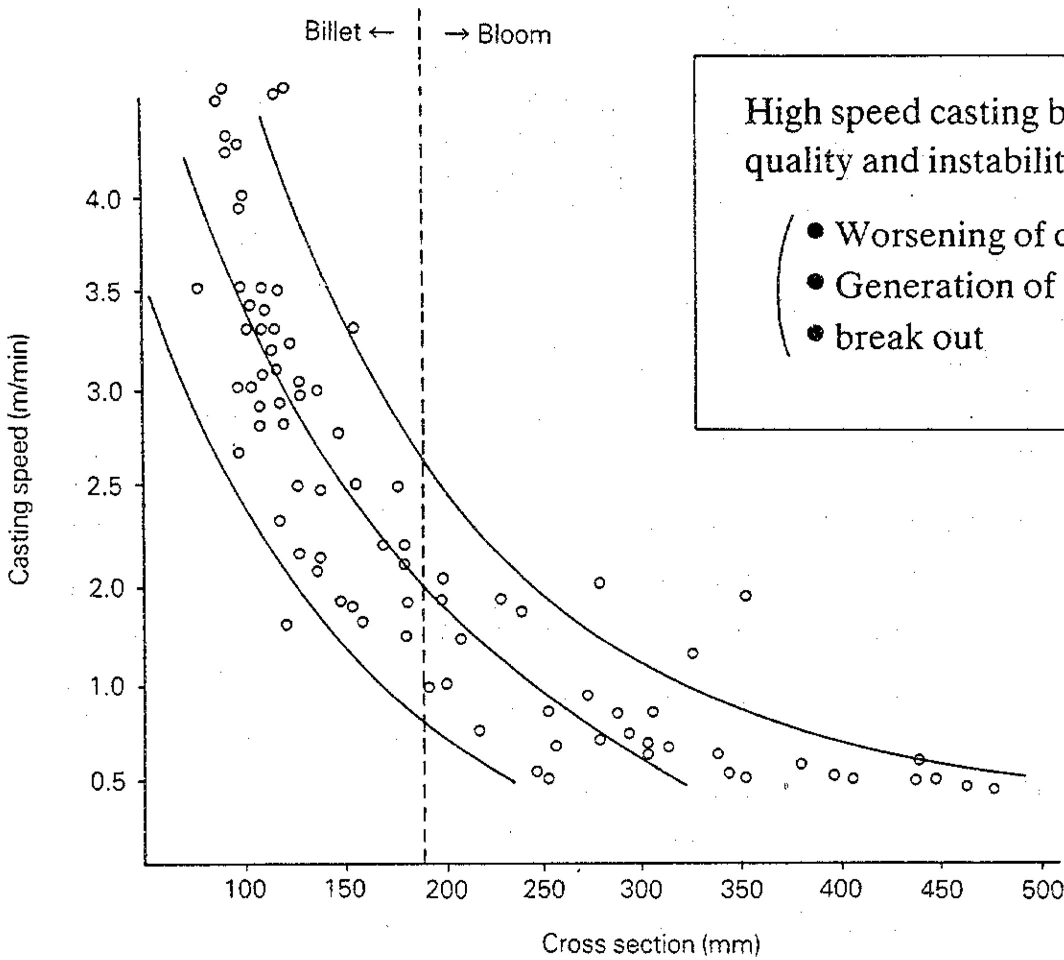
(2) Usage of dummy bar top charge system

(3) Mold and part of secondary cooling zone (foot roll and support roll) should be built in to one unit and be assembled off line

(4) Utilization of the computer for matching of tapping pitch from the melting farnace with processing time of continuous casting.

(15)

4.3.2 High speed casting



High speed casting brings about deterioration of quality and instability of operation.

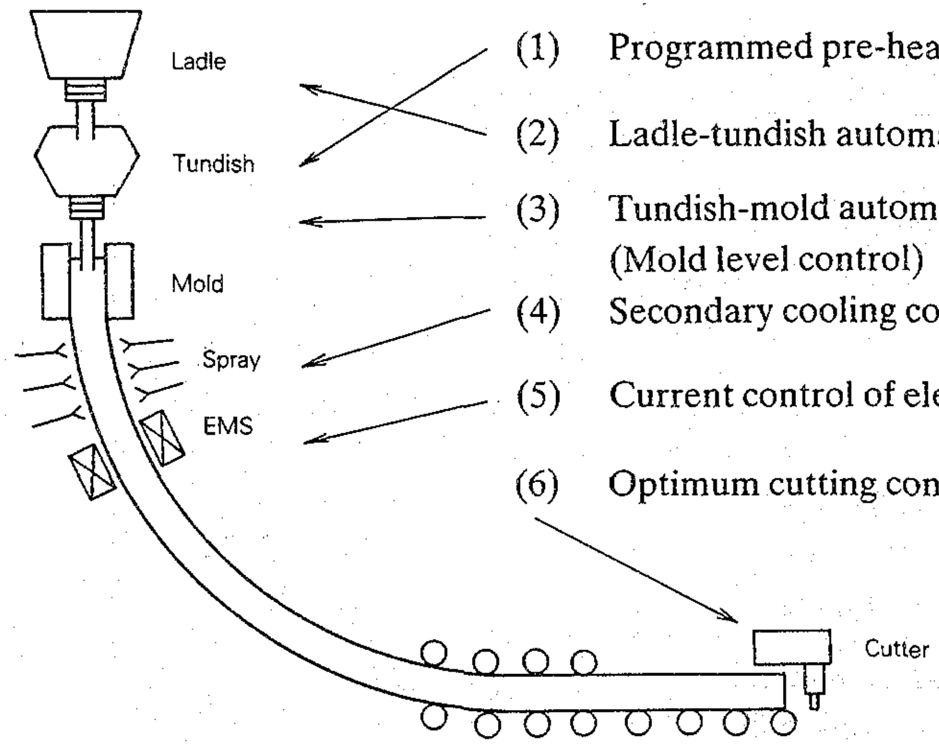
- Worsening of core segregation
- Generation of internal crack
- break out etc.

Fig. 12 The relation between casting speed and cross section of billet/bloom

(16)

4.4 Automation technique

An example for a general automation casting and adoption of computer



(1) Programmed pre-heating of tundish

(2) Ladle-tundish automatic casting

(3) Tundish-mold automatic casting
(Mold level control)

(4) Secondary cooling control

(5) Current control of electromagnetic stirring

(6) Optimum cutting control

(17)

5 Future themes

1. Improvement of continuous casting application ratio
   ... countermeasure for small lot
   ... compound sequence casting technique
   ... combination with different steel grades

2. Direct roll (process connected with rolling mill directly)

3. No man control

4. Automatic machine check and Senser development

5. Uniform quality of strand ... Bottom, top, sequence part of strand

6. Continuous casting section near to manufacture configuration

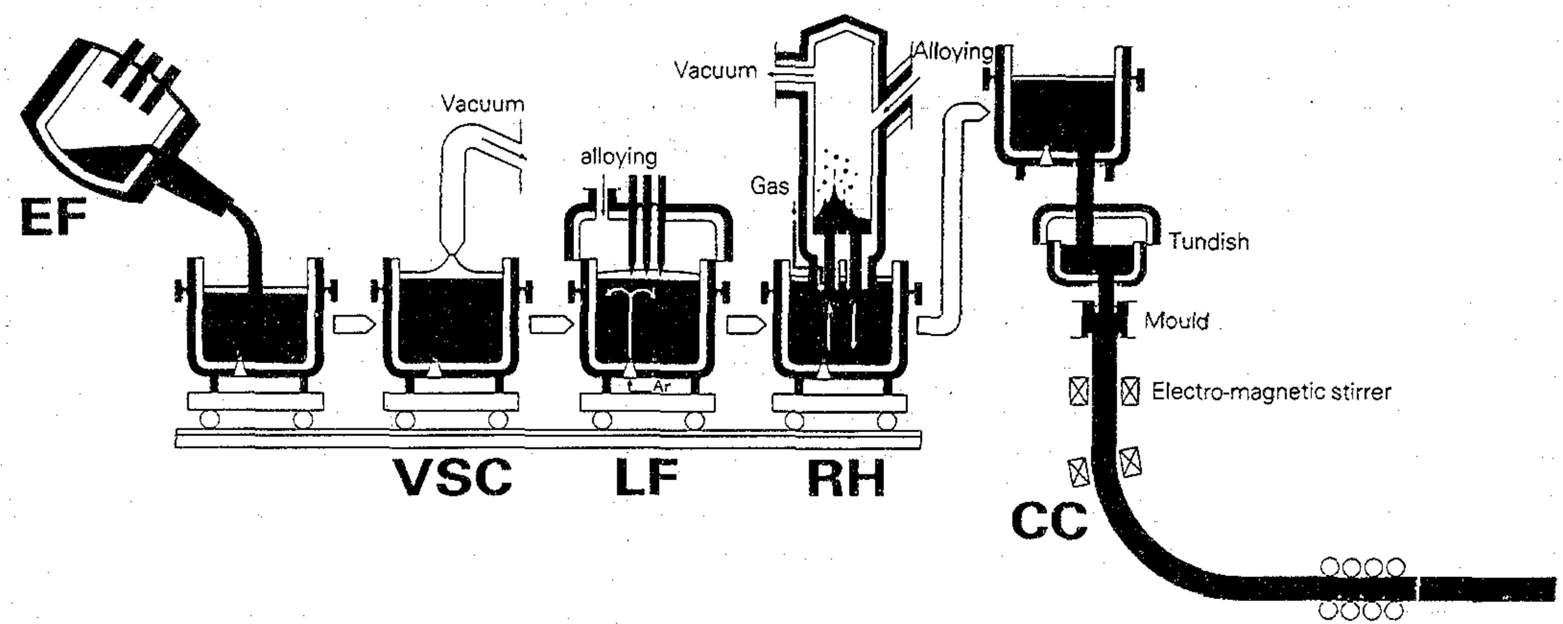
7. Technical innovation of refractory materials

(18)

Outline of bloom continuous caster in Aichi steel works

1. Purification of molten steel

EF−VSC−LF−RH process for higher quality



(1)

2. Specification of continuous caster

Machine capacity	60000 ^{Ton}/month
Machine type	Radius type with two points unbending
Radius	R : 16.0 ^{m}, 30.4 ^{m} curvilinear
length	67.2 ^{m}
Number of strand	2
Casting size	370 x 480 ^{mm}
Casting speed	Max 0.86 ^{m}/min
Ladle exchange	Ladle turret

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(2)

Secondary cooling zone	5
Electric magnetic stirrer	2 stages (level from bottom of mold : first 3.6 ^{m}, second 7.6 ^{m})
Pinch roll	6 stands roll drive
Cut off equipment	Gas torch cutter (LPG)
Dummy bar	Link and chain dummy bar side shift receiving type
Discharge system	Transfer table (max. 20 ^{m}/min, 50 ^{m} length) with table
Bloom marking	Automatic stamper
Process computer control	Nearly full process (Cooling system, Electro-magnetic stirring etc.)

(3)

Ladle capacity	max. 143 ^{Ton}/heat
Tundish capacity	20 ^{Ton} (800 ^{mm} depth, with SN)
Mold	Built up curved mold (Ni plating on Cupper mold)
Mold oscillation	Mechanical type sine curve Stroke 0 ~ 10 ^{mm} Cycle 20 ~ 200 ^{cpm}
Control of molten steel level in the mold	γ ray system
Prevention against the reoxidation of Molten steel	from ladle to tuntish = long nozzle from ladle to mold = Submerged nozzle

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(4)

5. Number of operaters

Foreman	1
Tundish repairing	4
Ladle + Mold	4
Control man	1
Cutter	1
Crane	1
Other	1
	11 Number/shift

6. Kinds of casting steel

(1) Structural carbon steel
(2) Structural alloy steel
(3) Spring steel
(4) Free cutting steel (S, Pb)
(5) Bearing steel

7. Production

7.1 Operation

1985/January ~ June

No3 80T EF total casting weight	(^{Ton}/Month)	60647
Continuous casting bloom weight	(^{Ton}/Month)	51912
Continuous casting ratio	(%)	85.7
Casting weight	(^{Ton}/heat)	130.54
Continuous casting succeed ratio	(%)	99.89
Heat casting time	(^{minutes}/heat)	88.9
Casting speed	(^{Meter}/minute)	0.45 ~ 0.65
heats/Dummy bar		17.17

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(6)

Heats/Tundish		2.44
Total casting hours/calender hours (%)		82.9
Water consumption (liter/minute)	Mold	4200
	Secondary cooling	180 ~ 270

7.2 Yield

(1) Yield of casting (%)

Ingot casting	Continuous casting			
	Number of heatsfor sequent casting (heat/cast)			
	1	2	3	4
95.5	93.5	95.5	96.8	97.2

(2) Yield of rolling (%)

Ingot casting	Continuous casting
86.8	94.0

(7)

NEWLY DEVELOPED FOUNDRY TECHNOLOGY APPLICABLE TO DEVELOPING COUNTRIES

October, 1985

NAGOYA INTERNATIONAL TRAINING CENTRE
JAPAN INTERNATIONAL COOPERATION AGENCY

MODERN FOUNDRY TECHNOLOGY IN JAPAN

Evaporative pattern full mould process with casting under vacuum condition developed several years before in Japan, is cheaper, more productive, easier to control process which shall be very useful especially to developing countries, under the condition that polystyllene beads are available in the country. The photo below show its procedures step by spet for easier understanding to foundry engineers.

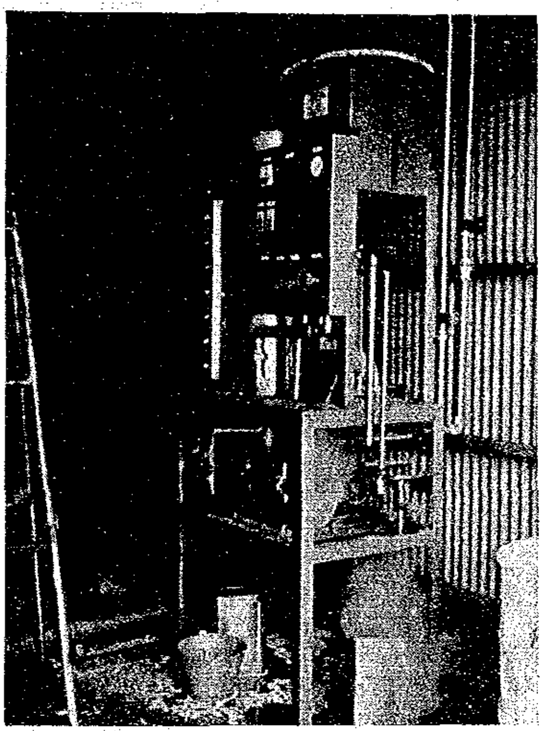


Photo 1. shows an equipment for primary foaming the beeds
(expansion of the beeds is about 3 time in volume by 110 --120 degree centigrade)

Photo 2. shows an equipment for 2ndly foaming the beeds
(expansion is about 30 - 40 time from the primary foamed beeds)

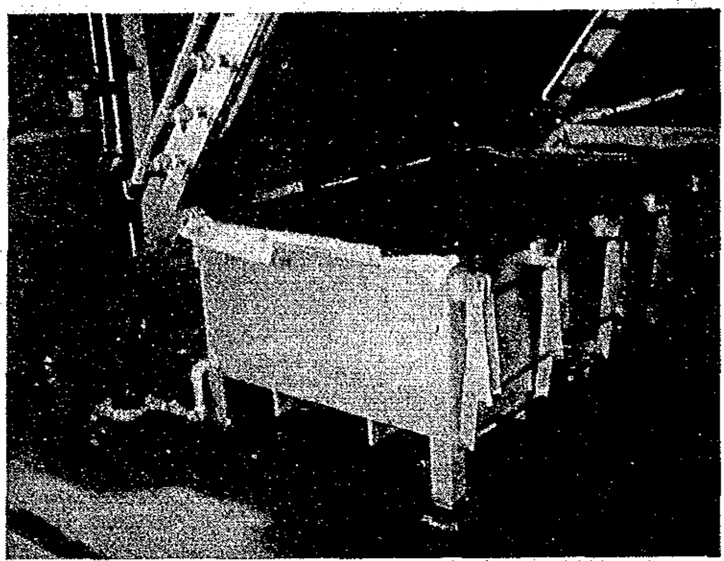
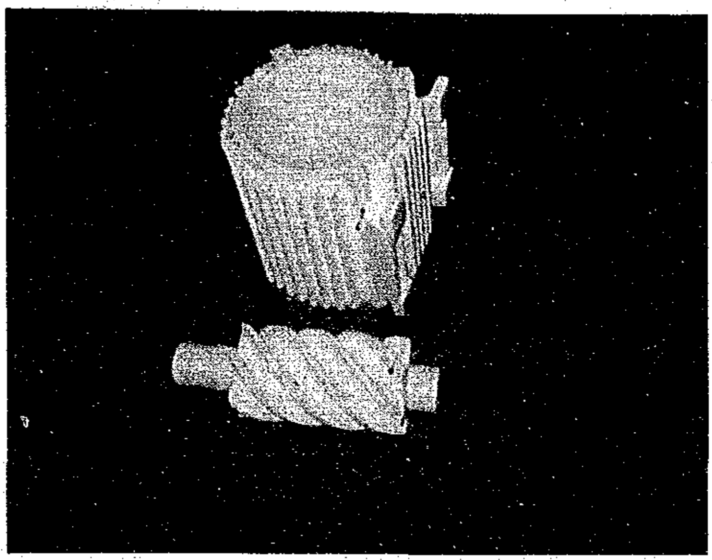


Photo 3. shows arrangement the foamed pattern

Photo 4 & 5 shows foamed patterns complete and ready for coating



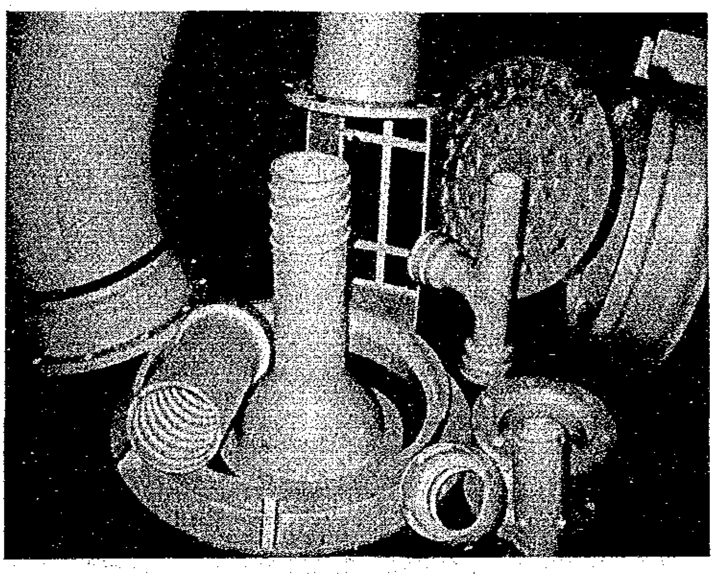


Photo 6', shows tank for dip in type coating

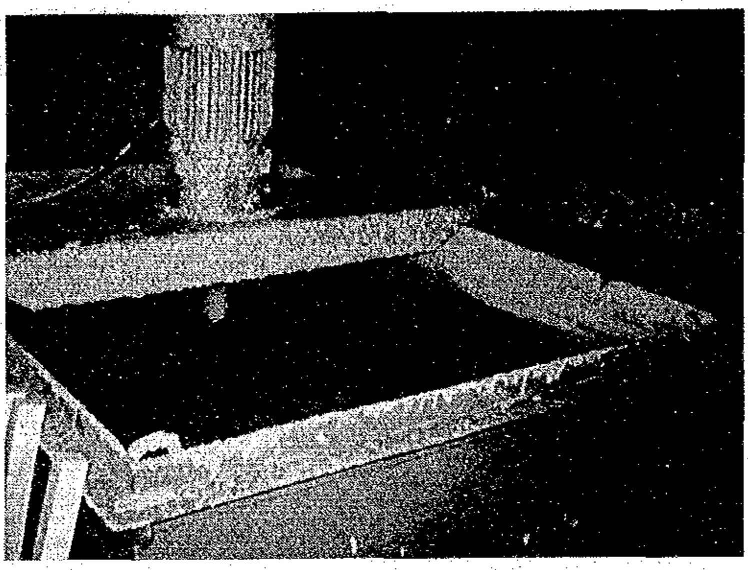


Photo 7. shows drying the coated full mould pattern