

5 技術指導

今回の技術指導にあたっては、次の2つの形態による現地指導を行なった。すなわち、セミナー形式による我国最近の技術水準の紹介、および現地において帰国研修員が当面する技術的問題点の解決方策の指導である。

今回巡回した3カ国においては、帰国研修のうち現在ガラス工業に従事している者の69%がビンガラス工業に、12%が板ガラス工業に、19%が試験研究機関に就職していることが事前調査により判明していたので、各国における技術セミナーのテーマとしては、最近の我国におけるビンガラス工業の新しい技術的動向の実例と、それを達成した技術を紹介し、その中に含まれる技術的問題点などを解説することにした。

また、現場における技術問題点の指導は問題の性格上、予め全般にわたる解答を準備することは出来ないので、たとえばガラスの組成と、それに由来するガラスの物性値などは、それらの計算プログラムを入れた携帯用コンピューターを携行して、現地での討議に活用し、また複雑な問題は巡回指導を終えて帰国後に、調査検討を行って回答するなどの方法をとった。

以下に、両指導の内容について報告する。

(1) 技術セミナー

技術セミナーでは、日本におけるガラスびん製造技術の注目すべき1つの成果として、資源とエネルギーの節約につながる軽量化びんの話を取りあげた。

ガラスびんは、容器として化学的な耐久性があり、気体、液体、臭気などを遮断し、洗浄・滅菌によって再利用が可能であること、食品を貯蔵するのに十分な硬さと、内容物の観察が可能な透明度をもつなど優れた特徴をもっているが一方、罐、プラスチック、紙容器などに比べて重く、且つわれやすい弱点がある。

もし、ガラスびんの機械的強度を損うことなく、その軽量化が達成できれば、上記の特徴を活かした容器の価値が確保されるとともに、ガラスの溶融、成形、搬送などに必要な資源およびエネルギーの節約につながる。ところが、ガラスびんの軽量化には、びんの肉厚減少と、これに伴う機械的強度の低下が起るため、軽量びんには、それを強化する方策が不可能となる。

一方、これまで建築用、車両用などの板ガラス、あるいは比較的簡単な形状の食卓用ガラス器類の一部には、急速空冷による物理的強化法が実用化されているが、びんのように内容積に比べて口径の小さい容器で、しかも軽量化のために肉厚を薄くした容器に対して、この急速空冷による物理的強化法の効果は期待できない。

そこで、日本のあるびんガラスメーカーが、世界で初めて、化学強化法による軽量化びんの量産に成功したが、それに附随する技術的問題点の解説は、途上国において従来タイプのびんの生産に従事している技術者たちにとっても、技術的関心を喚起し、刺激となり、彼等の日常の製造方式に対する新しい見直しの機会をも提供することとなった。

たとえば軽量びんにおいては、単に肉厚が薄いのみならず、それより高い均等性が要求されるが、各種成形方式における最低肉厚発生箇所の追究、均等肉厚の得られやすいびんの形

状の探求などを経て最適成形方式に辿りつくに至った経過をはじめ、原料、調合、溶融、成形後のコーティングなど、製造技術全般にわたる各工程の重要性が再認識された。

セミナーの会場で聴講者に配布した英文の要旨は、本報告書の巻末に収録した。次に各国で開催したセミナーの状況について報告する。

タイ

タイでは、国防省所管の Bangna Glassworks (旧名 Glass Organization) において帰国研修員9名(全員製びん工業に勤務し、その中2名は民間企業の副社長および工場長)に対して、上記の技術セミナーを行ない、終了後、質疑応答が交された。(写真52)

また、工場視察のあと試験室において品質管理技術に関する現場指導を行なった。(写真53)

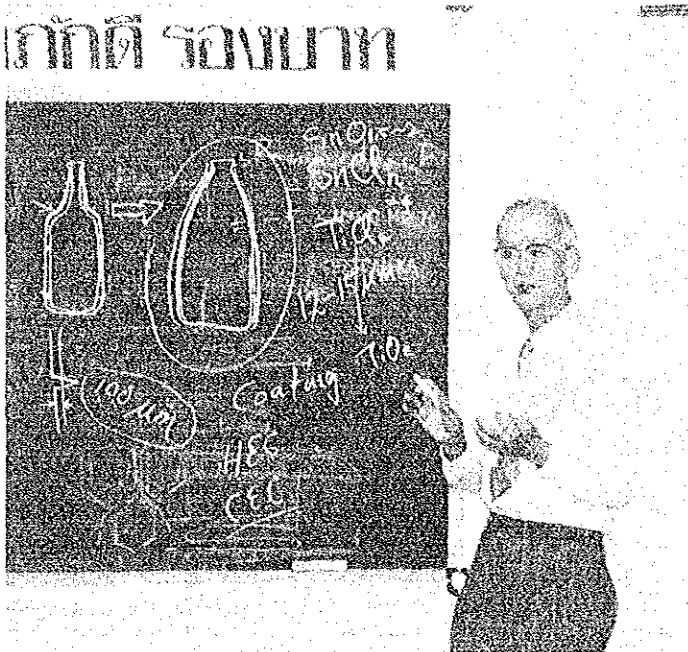


写真 52
Glass Organization
における技術セミナー
一風景



写真 53
Glass Organization
試験室における現場
指導

インドネシア

インドネシアでは、工業省・工業研究開発局所管の窯業研究開発試験所（Ceramic Research and Development Institute）のあるバンドンにおいて、帰国研修員を含む同所所員のほか、バンドン市内のみならず主都ジャカルタなどジャワ島各地の各種国立機関や民間企業から、62名にのぼる技術者が、われわれのセミナー出席し、15分間のティークレイトをはさんで、延々2時間におよぶ講義と質疑応答が繰り広げられた。会場における聴講者の雰囲気は、熱心かつ静粛で、新しい知見を少しも聞き洩らすまいとする態度が十二分に察せられた（写真54）。

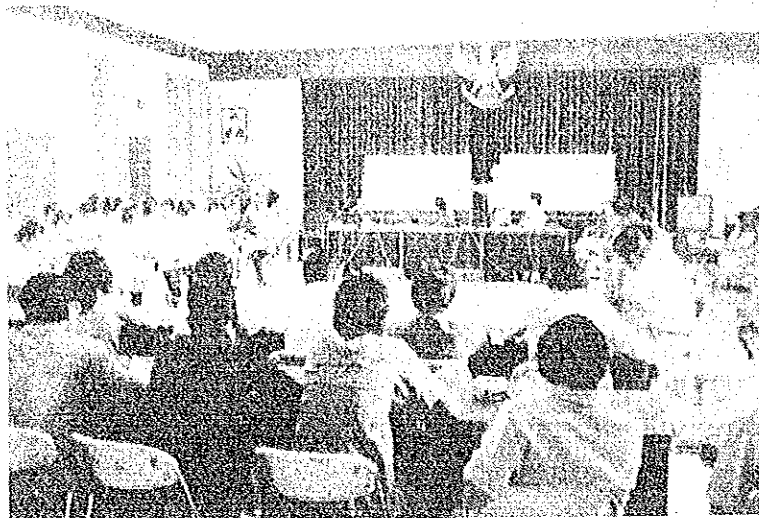


写真54

窯業研究開発試験所
における技術セミナー風景

窯業研究開発試験所（CRDI）は、出席者全員に対し、Pratopo Soemitro 所長および巡回指導班の早川惇二、片岡長正両名の署名入りセミナー聴講証明書を発行した。

P. Soemitro 所長は、またわれわれ巡回指導班の3名に対してもそれぞれに感謝状を授与して、その労をねぎらった。（写真55）

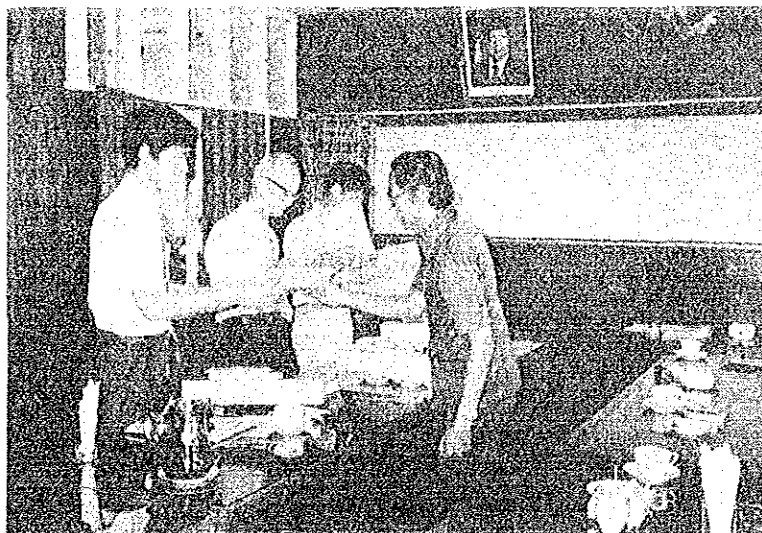


写真55

巡回指導班に対する
P. Soemitro 所長か
らの感謝状の授与

思うに、インドネシアにおける技術セミナーが巡回指導班にとって、全く予想外の盛会であったのは、1に配慮のゆきとどいた施策と運営をもって、帰国研修員に対するJICAの巡回指導班を受け入れた窯業研究開発試験所(CRDI)の所長をはじめスタッフ各位の尽力によるものであり、指導班にとってもその尽力に対しては深甚の謝意を禁じえないところである。

窯業研究開発試験所(CRDI)のガラス部門は、日本の工業技術院・大阪工業技術試験所(GIRIO)の第4部ガラス部門と同様の立場にあるので、セミナーを行った翌日には(CRDI)側からと、(GIRIO)側からの双方が研究内容を紹介し合って、相互理解を深めることができた(写真56-1、56-2)

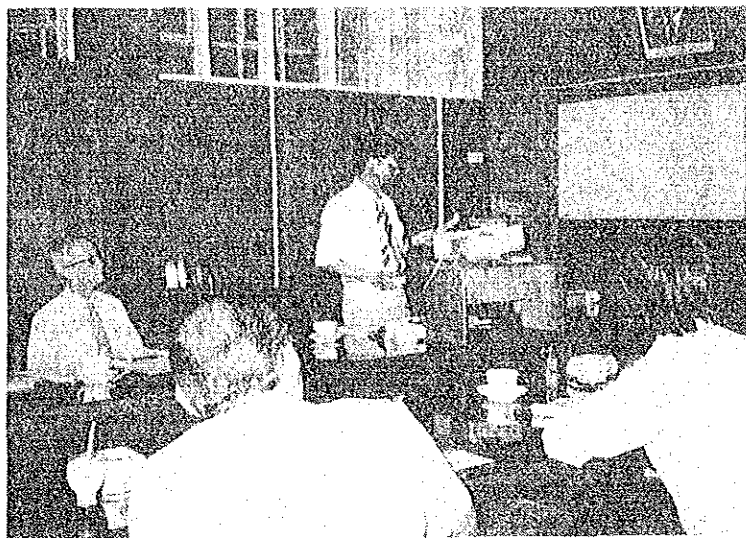


写真 56-1

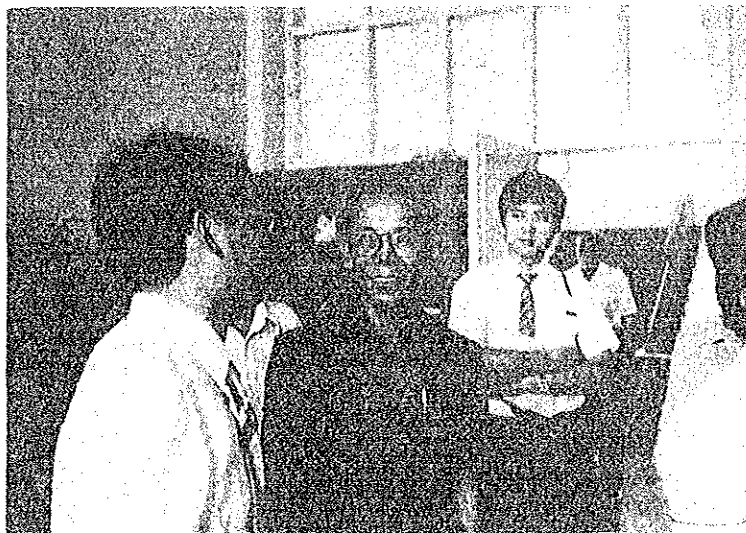


写真 56-2

インドネシアでは、またスラバヤ市にある、もと国有かつ国営のびんガラス工場で、近來、国有の企業組織になったP.T.Iglas社を訪れ、3名の帰国研修員の活躍ぶりを視察するとともに現場における技術指導を行なった。(詳細は事項)

フィリピン

フィリピンにおいては帰国研修員11名中、現在8名がガラス工業に従事している。その中5名がびんガラス、3名が板ガラスであり、セミナーは巡回指導班の宿泊ホテルの会議室を利用して行なった(写真57-1、57-2)



写真 57 - 1

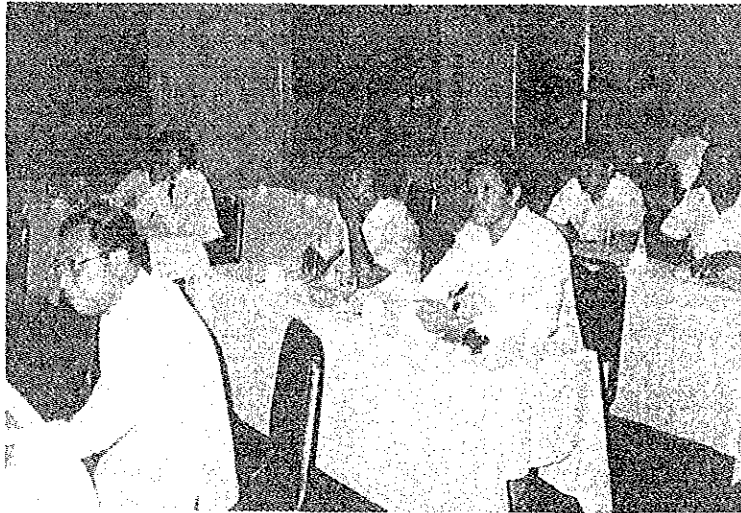


写真 57 - 2

したがって、セミナーの内容は、3名の板ガラス工業に従事する帰国研修員にとって関心の薄いものではなかろうかとの懸念が事前にはあったが、3名とも終始熱心に聴講し、とくに空冷強化効果の得難い薄板ガラスへの化学強化法の可能性に少なからぬ関心のあることが示され、巡回指導班にとっても、この技術セミナーのテーマが、幸いこの国においてもまた決して不適切なものではなかったことを確認できた。

東南アジア諸国連合機構(ASEAN)内のガラス企業やCRDIなどが、事務局を持ち廻りでガラス会議を年来開催してきたが、今回われわれが行なったガラス工学コース巡回指導における技術セミナーのテーマや内容などは、その会議のセミナー向きにも充分ふさわしいものであると、フィリピンでの最後のセミナーを終えるに際して、その会議に出席したことがある帰国研修員の1人が感想を語ってくれた。

(2) 現地における技術指導

カレットの処理について

各国の現地で行った技術指導をまとめると表10の様になる。この指導項目を見るといずれの会社においても粘度に関連した項目について関心が深い。これは粘度がガラスの成形に関係しており生産性が各企業にとって重大な問題となっていることを示している。ガラスの品質管理の一環として軟化点管理がある。この軟化点はまた成形温度の指示値ともなっている。この軟化点とガラス組成との関連を明らかにすることにより組成変動の原因を明らかにすることができる。この軟化点の変動の原因を考察してみるとガラス原料中でケイ砂はいずれの国々においても国内産でありその含有量も高く、一定である。この他の天然原料としては炭酸ソーダがある。これも純度が良く、一定している。原料の大半を占めるのはカレットである。このカレットの純度が必ずしも一定しているものではない、というのはガラスの種類がビンガラスであってもその組成は異なっている。この変動は各社の使用する原料やこれまでの溶融歴などに関連してケイ砂などの変動よりも大きいと想定される。

これらの事実を十分に考慮して原料管理を行う場合カレット管理はケイ砂採掘の場合と同様に各カレット置場のカレット分析を行いこのカレット混合をホッパー単位で行い、平均化し常に一定の組成となるように努力することが軟化点、比重、膨脹係数などの変動をできるだけ小さくすることになり安定な操業をすることができるのではないと思われる。このカレット作成技術開発の進展がより安定なガラス溶融につながる。

粘度と組成と生産性について

各国ビンガラス会社における粘度については軟化点以外の測定は余り行われていない。とくに低粘度に対する測定は全く無い。

各企業におけるこれらの対応は Ohkohtin や Lakatos の式の適用が可能である。しかしこれら低粘度は主に溶融炉内のガラスの流れについての対応があり、耐火物との関連からガラスの均質性や炉の寿命、総ガラス生産量に関連している。この低粘度を問題にする日はそう遠くないと思われる。

ガラス生地着色について

粘度以外での現地指導ではガラスの着色が問題になっている。ガラスの着色は主に鉄によるものである。鉄の含有量を原料中から少なくすれば解決することができるが実際にはカレットを50%以上使用しているので鉄(Fe_2O_3)を除去することはできない。ガラス中の鉄は Fe^{2+} と Fe^{3+} に分かれている。この Fe^{2+} と Fe^{3+} イオンの割合はガラス溶融時の酸化、還元に関係して決る。ガラスの溶融を繰り返すと Fe^{3+} が多くなる。 Fe^{3+} は350~400 nmに吸収があるため、短波長側の光が吸収されてガラスは黄色味が多くなる。一方、還元状態でガラスを溶融すると Fe^{2+} が多くなる。

Fe^{2+} は1050~1100 nmに吸収がある。このため近赤外域の光が吸収されガラスは青味がかかった色となる。ガラスの色としては黄色がかかった色よりも青味がかかった色の方

が好まれるので、ガラス中のFeイオンは Fe^{2+} イオンにした方がよい。これにはガラス原料中に還元剤を入れ、熔融時の雰囲気を変元状態にしておく必要がある。カレット中の鉄を Fe^{2+} イオンにするには還元剤を使用することが望まれる。

UVグリーンガラスについて

ビンガラスの色による分類は無色透明なもの、アンバー、グリーン、乳白色などに分けられる。ソフトドリンクは無色なものグリーンのものに分けられる。このグリーン着色はコーラのビンで代表されるジョージアグリーンとセブンアップのエメラルドグリーンがある。

エメラルドグリーンも400nmを吸収するものと400nmを70~75%透過するものがある。400nmを透過するグリーンガラスビンは内容物が紫外線と無関係のものに使われ、400nm以下を吸収するビンは紫外線で内容物が分解または変質するものに使われる。

インドネシアのP.T.Iglasで現地指導を行ったのはこの400nm以下を吸収するエメラルドグリーンである。現地ではこのガラスをUVグリーンガラスと呼んでいる。エメラルドグリーンガラスは Cr_2O_3 をガラス中に0.1~0.2%含有させるのみで簡単に着色させることができる。ソーダ石灰ガラス中のCrイオンは Cr^{3+} と Cr^{6+} が共存し、このうち、 Cr^{6+} イオンが短波長の紫外域を吸収する。この Cr^{3+} と Cr^{6+} の割合はガラスの酸化・還元依存するガラスを酸化の状態で熔融すると Cr^{6+} の生成が多くなりガラスは短波長を吸収する。

これらのことからUVグリーンガラスは普通のCrグリーンガラスに酸化剤(例えば硝酸ソーダ)等を加えることにより得ることができる。しかしガラスの酸化・還元は必ずしもこの酸化剤のみに依らないので更に細かい調整(熔融雰囲気)が必要となる。

このP.T.IglasにおけるUVグリーンガラスの討論以後、巡回指導班と討論したのと同じUVグリーンガラスの原料組成が5月中旬に現地から送付され、試験熔融の依頼があった。指導班は直ちにこのガラス原料を熔融し、このガラスの分光透過率曲線を測定し図1の結果を得た。この透過率曲線から明らかなように400nm以下の短波長は総べて吸収する完全なUVグリーンガラスとなっている。

このガラスと比較するため日本で作られたグリーンガラスの透過率曲線を図2に示す。このガラスでは400nmを70%透過しUVグリーンガラスと明確な違いがある。このUVグリーンガラスの色は黄色のかかったグリーンガラスのため、赤色を少しカットし、グリーンの色を鮮明にすることもある。P.T.Iglasの試験熔融が成功したので、指導班の現地での討論はこの会社にとって非常に有効な指導であったと考えられる。

各国ガラス会社の試験、検査室が充実し、種々の物性値が測定されるようになり、ガラスの性能がカタログ等に記載されるようになってきた。この物性値は測定に用いた機器による差がある。このため各国共通した標準ガラスでこれらの機器を校正することが必要である。このガラス工学研修コースはこれらの点を考え、毎年帰国する時、少量ではあるが標準ガラス(大工試製)を研修員に持ち帰らせている。今回の調査ではこのガラスを標準

にして物性値の管理を行っているという工場はなかった。これはガラスそのものが少ないため実際に使用できないことが明らかとなったので、早急に必要とする会社を送り、実際に使えるようにしたと考えている。これらの事は研修員との友好関係を強くするばかりでなく、技術的關係も含めて更に強い関係を作り出す絆となるものと確信する。

表10 現地における技術指導

国名	会社名	技術指導項目
タイ	Glass Organization	組成—粘度関係式、軟化点測定試料作成技術、ガラス中の鉄イオンとガラスの着色との関係および溶融炉の色替え方法
	Siam Glass Industry Co., Ltd.	組成—粘度関係式
インドネシア	P.T. Iglas CRDI	組成—粘度関係式、UVグリーンガラス、ガラス溶融炉の発熱体支持方法
フィリピン	Union Glass & Container Corporation	組成—粘度関係式
	Republic Glass Corporation	組成—粘度関係式、MgOの比色分析法



写真58 インドネシア、P.T. Iglas における現地指導

UVグリーン・ガラスについて帰国研修員と工場長を交えて長時間にわたって討論をした。

左から、早川、片岡、工場長 Djoko Satmoko 氏、帰国研修員の Wimboyono、Soegito、Semantri の各氏（P.T. Iglas 社の会議室にて）

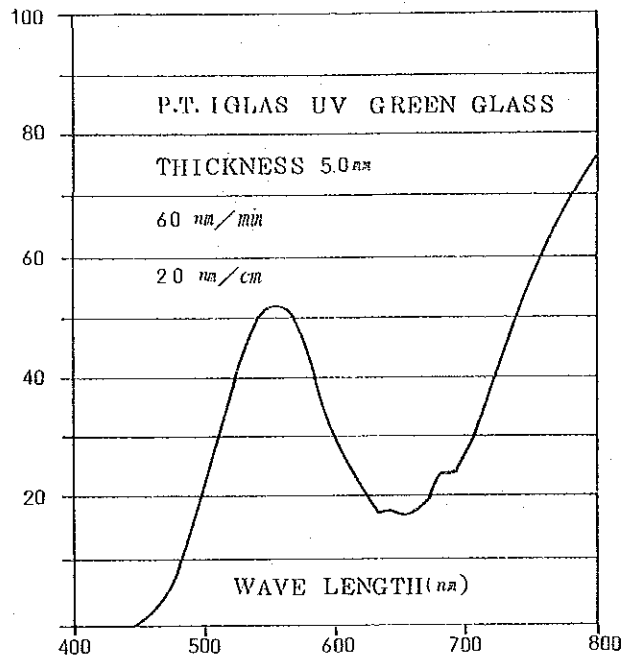


図1 P.T. Iglas社 UVグリーンガラスの透過率曲線
(400nm以下がカットされている)

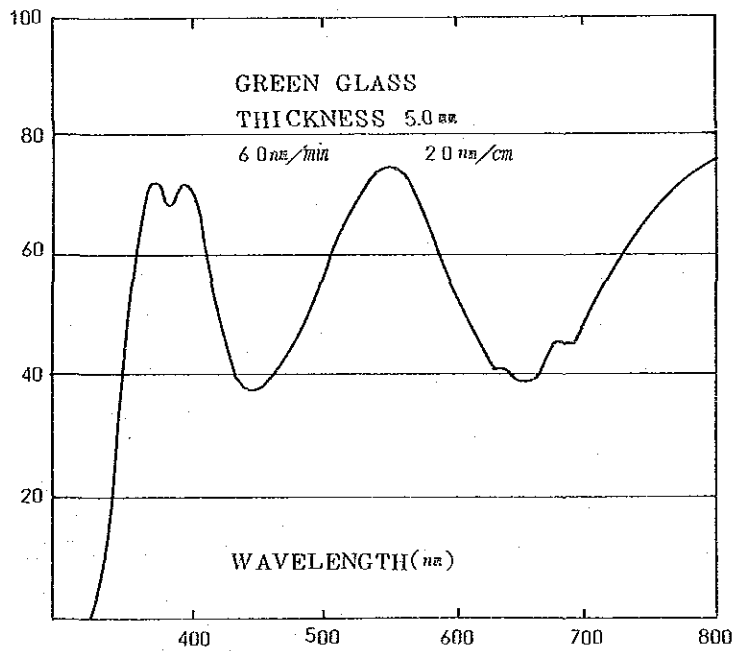


図2 日本のピンメーカーのグリーンガラスの透過率曲線
400nm以下がカットされていない
400nmの透過率70%

第3章 総 括

1 タイ、インドネシア、フィリピン3カ国の帰国研修員総数35名中26名をフォローアップすることができた。このうち研修時と同一企業又は研究所に就職しているものは24名であり、同種企業に移った者は2名であった。ガラス工業がこれらの国では成長産業であるため技術者の移動が少く、定着率が高いと考えられる。またフォローアップすることができなかったが別の業種に移った研修員には研究者よりも技術関係者が多い。

帰国研修員はそれぞれの部門で責任者として企業を支えており、初期の研修員達は技術職から管理職へ移り、工場長、副社長としてそれぞれ国のガラス工業の指導的立場にある。

これらの点からガラス工学集団研修の帰国研修員がこれらの国のガラス産業の育成に果たした役割は大きい。

2 この3カ国におけるガラス工業はビンガラス、板ガラス、食器ガラスの順に成長している。

ガラスビンはソフトドリンク、ビール、ワイン、ウィスキー、その他飲料用食品、医薬品等の容器として確立しており、このビンガラス産業は成長産業であるソフトドリンク産業、食器、医薬産業の発展とともに今後ますます成長し、その規模はやがて先進国の様相に到達することが予想される。

この3カ国でのビンガラス工業への帰国研修員は17名で全体の半数である。JICAの研修コースはこれらの背景を考慮して見学講義等が編成され、このビンガラス工業の発展に貢献してきた。今後ともこれらの国におけるガラス工業の発展に伴った研修プログラムが作成されることが望まれる。

3 今回、巡回指導班が3カ国で開催したセミナーのテーマである化学強化ビンの講義はガラス関係者ばかりでなく、他のセラミック関係者にも興味を持たせ、ガラスの強化法としての評価を受け、インドネシアでは国立窯業試験所の呼びかけに応じて、その聴講者はジャワ島各地から62名に達した。

4 ガラス産業はエネルギー多量消費産業であるため、エネルギー資源国の産業ともいわれている。しかし素材としてのガラスは重く、需要はエネルギー消費国である。このため省エネルギー、省資源がこの産業での急務となっている。ガラスビンの使用は途上国、先進国とも今後増加し、ビンの回収率の向上とともにガラス原料中のカレットの割合は高くなり、ガラス溶融の燃料コストを下げ、省エネルギー、省資源に貢献すると思われる。このカレットを主体としたガラス溶融法及び各種ガラス物性への影響を検討する必要がある。

5 各国におけるビンガラスメーカーはそれぞれ数社ずつあるため競争が激しい。このため各社ともビンのコストを下げるため、ビン製造機を早める努力をしている。各社のガラス技術者はビン成形とガラスの粘度との関係を知る必要が生じてきた。このため現地における技術指導はこの点に質問が集まった。

また、品質管理の点からも分析技術を迅速化し、ガラス及び原料の変動に対応する方法などの技術指導、コンピューター利用技術、省エネルギー技術の紹介などが要望された。

今後のガラス工学研修コースとしては、今回の調査結果や各国ガラス工業の要望などを取り入れ、より充実したものにして行くことが望まれる。

別添資料 1. クエスチ ョ ネア ー
(帰国研修員用及び所属機関用)

(資料 1 - 1)

QUESTIONNAIRE
TO
EX-PARTICIPANTS
(GLASS TECHNOLOGY COURSE)

Country _____

Name _____ (Underline surname)

Date of birth _____ Sex M or F

Home address _____

Year of participation 19 _____

Occupation

Name of your organization _____

Address of your organization _____

Your present post _____

Your responsibility _____

Career after the participation in the course

Dates of service	Title of post	Organization
—		
—		
—		
—		
— present		

1. APPLICATION

- (1) Did you know anything about this course before your application ?
If your answer is "yes", how did you come to know it ?

- (2) Did anyone recommend or order you to apply for the course ?
Who was he ? Was it compulsory ?

- (3) Who had the strongest influence on the selection of the
applicants when you were chosen ?

- (4) Did you have any difficulties at the time of application,
preparation or departure ?

- (5) When did you obtain "general information" (information booklet
for the course) ? Did you read it before you applied ?

- (6) Do you think the general information provides you with enough
information on the training course ? Any items you wish to
be added ?

3. ITEMIZED EVALUATION ON THE COURSE

Please evaluate each item below by putting one of alphabets(A,B, C,D) into the parenthesis and describe the reasons.

- A: very useful
- B: useful
- C: not useful
- D: not participated

(1) General orientation on Japan

() _____

(2) Course orientaion on training

() _____

(3) Japanese language

() _____

(4) Lectures & practices on the properties of glass by GIRIO

Please pick out the lectures and practices which have proved to be the most useful/beneficial to your job.

Subject _____

Reasons

- (5) Lectures on the glass technology by private institutions
Please pick out the lectures which have proved to be the most useful/beneficial to your job.

Subject _____

Reasons

- (6) Factory observation

Please pick out the names of the companies whose observation benefited you most. (See attached list)

- a. Sheet glass

Names _____

- b. Container glass

Names _____

- c. Tableware glass

Names _____

- d. Optical glass

Names _____

- e. Technical glass

Names _____

Factory Observation List

a. Sheet glass

- 1) Asahi Glass Co., Ltd.
- 2) Central Glass Co., Ltd.
- 3) Nippon Sheet Glass Co., Ltd.

b. Container glass

- 1) Dai-Ichi Glass Co., Ltd.
- 2) Daiwa Glass Co., Ltd.
- 3) Hiroshima Glass Industry Co., Ltd.
- 4) Ishizuka Glass Co., Ltd.
- 5) Maruo Glass Co., Ltd.
- 6) Nippon Glass Co., Ltd.
- 7) Nakanishi Glass Art Co., Ltd.
- 8) Osaka Seiko Glass Co., Ltd.
- 9) Shin Nippon Glass Co., Ltd.
- 10) Toyo Glass Co., Ltd.
- 11) Uenaka Glass Co., Ltd.
- 12) Yamamura Glass Co., Ltd.

c. Tableware glass

- 1) Daigo Glass Co., Ltd.
- 2) Ishizuka Glass Co., Ltd.
- 3) Kagami Crystal Seizosho Co., Ltd.
- 4) Koshida Glass Works, Ltd.
- 5) Kyoritsu Glass Co., Ltd.
- 6) Sasaki Glass Co., Ltd.
- 7) Sanyu Art Glass Co., Ltd.

d. Optical glass

- 1) Minolta Camera Co., Ltd.

e. Technical glass

- 1) Akagawa Koshitsu Glass Industry Co., Ltd.
- 2) Elko Co., Ltd.
- 3) Hoya Glass Co., Ltd.
- 4) Kokura Glass Industry Co., Ltd.
- 5) Miyahara Calibrated Glassware Mfg. Co., Ltd.
- 6) Nippon Electrical Glass Co., Ltd.
- 7) Ogura Glass Mfg. Co., Ltd.
- 8) Shibata Hario Co., Ltd.
- 9) Sogo Rikagaku Glass Mfg. Co., Ltd.

f. Others

- 1) Asahi Silicate Industry Co., Ltd.
- 2) Asahi Fiber Glass Co., Ltd.
- 3) Chemical Research Laboratory of Kyoto University
- 4) Chugairo Kogyo Co., Ltd.
- 5) Daihatsu Industry Co., Ltd.
- 6) Fujitsu Co., Ltd.
- 7) Fuso Machine and Mold Mfg. Co., Ltd.
- 8) Matsushita Electric Industry Co., Ltd.
- 9) Maruzen Sekiyu Co., Ltd.
- 10) Mitsue Mold Mfg. Co., Ltd.
- 11) Nippon Glass Chemicals Co., Ltd.
- 12) Nippon Fiber Glass Co., Ltd.
- 13) Nippon Silica Sand Co., Ltd.
- 14) Nippon Ferro Co., Ltd.
- 15) National Crown Co., Ltd.
- 16) Okumura Pot & Crucible Mfg. Co., Ltd.
- 17) Okuno Chemical Industry Co., Ltd.
- 18) Osaka Gas Co., Ltd.
- 19) Rigaku Denki Kogyo Co., Ltd.
- 20) Sharp Corporation, Ltd.
- 21) Shimadzu Seisakusho Ltd.
- 22) Shiotani Glass Co., Ltd.
- 23) Showa Denki Glass Co., Ltd.
- 24) Shin Nippon Iron Works, Ltd.
- 25) Tateishi Denki Co., Ltd.
- 26) Toyo Kogyo Co., Ltd.
- 27) Union Glass Co., Ltd.
- 28) Yamabishi Industry Co., Ltd.

QUESTIONNAIRE
TO
COMPANY/INSTITUTION
(GLASS TECHNOLOGY COURSE)

PART 1

1. Country _____
2. Name and address of your organization
Name _____
Address _____
3. Type of your organization(Check one)
 - a. Governmental ()
 - b. Semi-governmental ()
 - c. Private ()
 - d. others ()
4. Outline of your organization
Head Office _____
Year of establishment _____
Capital _____
Number of Employees _____
5. Organization structure
Please attach an organization chart to this questionnaire,
indicating (1) and (2) in the chart.
 - (1) The number of the personnel in each section/department/
plant
 - (2) The positions of each ex-participant

(Please proceed to PART 2, if your organization has no production line.)

6. Production lines of your company

7. Share of your products in your country

Product	Share(%)		Annual Production (ton/year)
	Domestic	Export	
Sheet 1983 1978			
Container 1983 1978			
Tableware 1983 1978			
Bulb&Tubing 1983 1978			
Others 1983 1978			

8. Usage share of the products of your company

	Building	Automobile	Electric	Others	
Sheet glass					
	Soft drink	Liquor	Foods	Medicine	Others
Container glass					

9. Source and quantity of the raw materials consumed in your company (ton/year)

	Silica sand	Soda ash	Limestone	Dolomite	Feldspar	Others
Domestic						
Import						

10. Purity of the raw materials

	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	SO ₃
Silica sand								
Soda ash								
Limestone								
Dolomite								
Feldspar								
Others								

11. Fuels for melting and heating glass

	Gas		Oil	Coal	Elect-ricity
	Natural	Producer Town	Heavy Kerosine		
Tank					
Pot					
Annealing					
Decoration					

12. Facilities of your company

Items \ Furnace	Tank	Pot	Annealing	Decoration
Number				
Capacity				
Products				
Daily pull				
Repair Interval (Month)				

Items \ Feeders	Emhart : 144	Emhart : 81	Emhart : (Others)	BHF	Others
Number					
Dimension (L x W x D)					

Machine (I)	I. S.	Lynch-10	Baby Lynch	Others
Items				
Number				
Capacity				
Products				
Overhaul Interval (Month)				

Machine (II)	Press Machines		Paste Mold Machine (H28) and Others	ADP		Others
	Motor Driven (MDP)	Air Driven (ADP)		PBS	PBM	
Items						
Number						
Capacity						
Overhaul Interval (Month)						

Machine (III)	For Sheet and Plate Glass
Items	
Name of system	
Number	
Capacity	
Daily pull	

Machine (IV)	For Lamp Bulb, Tubings and Illuminating Glassware
Items	
Names	
Number	
Capacity	
Daily pull	

(END of PART 1)

PART 2

1. To what extent does your organization know about the glass technology course ? (Check one)

- a. know the course very well ()
- b. know the outline ()
- c. know the course only by name ()
- d. do not know ()

2. Does anyone of the superiors usually recommend some of his subordinates to apply for the course ?

- a. always ()
- b. sometimes ()
- c. never ()

How and who select one(s) to apply ? Are there any qualifications on your side ?

3. Do you think the participation to the course (by your subordinates) has brought any benefits to your organization, or any transfer of knowledge/skill/information has been achieved ?

What would they be, if any ?

7. Please list all other technical trainings/scholarships conducted by overseas organizations in the field of glass technology.

- a. (Country)
- b. (Name of the conducting organization)
- c. (Name of the training/scholarship)
- d. (Duration)
- e. (Number of ex-participants sent from your organization)
- f. (Contents of the training/scholarship)

(1)	a. _____	f. _____
	b. _____	_____
	c. _____	_____
	d. _____	_____
	e. _____	_____
(2)	a. _____	f. _____
	b. _____	_____
	c. _____	_____
	d. _____	_____
	e. _____	_____
(3)	a. _____	f. _____
	b. _____	_____
	c. _____	_____
	d. _____	_____
	e. _____	_____
(4)	a. _____	f. _____
	b. _____	_____
	c. _____	_____
	d. _____	_____
	e. _____	_____
(5)	a. _____	f. _____
	b. _____	_____
	c. _____	_____
	d. _____	_____
	e. _____	_____

(END)

Prepared by: _____
Rank/title: _____
Date: _____

Bangkok,
April 2, 1984

Dear Sir,

We have the great pleasure of submitting herewith our Summary Report of the Technical Follow-up Team for the ex-participants of the Group Training Course in Glass Technology of JICA.

Since this training course has now fourteen years' history, there are more than a hundred ex-participants in all in twenty four countries throughout Far East, Southeast Asia, Southwest Asia, Mid-East, Near East, Egypt, Latin America, etc.

Among them, Thailand has sent more than ten glass engineers to participate in the training course. Therefore, we took Thailand as the first theatre for the follow-up mission which realized after long years.

Through the meetings held on this occasion, we received a good many kind suggestions from the Authorities concerned and ex-participants for further improvement of the training course.

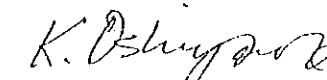
As described in our report, we would like to make our efforts to have your suggestions reflected in the future training programme.

We sincerely thank you very much for your kind and helpful co-operation.

Yours faithfully,


Junji HAYAKAWA


Naqamasa KATAOKA


Kazunori OSHIYAMA

Technical Follow-up Team,
Glass Technology, JICA

Summary Report of the Technical Follow-up Team for JICA Ex-participants
of the Group Training Course in Glass Technology

I. INTRODUCTION

It is our great pleasure to have had the opportunity to visit Thailand as the member of Technical Follow-up Team. After having completed all the schedule, the team submits herewith a summary report on its 6 days of follow-up activities for the reference of the officials of the authorities concerned in Thailand.

At the same time, we should like to express our deepest gratitude for warm welcome and kind cooperation extended to us during the whole period of our stay in Thailand.

II. TEAM MEMBER

- Mr. Junji HAYAKAWA : Senior Research Engineer of 4th Dept.,
Governmental Industrial Research Institute,
Osaka, Agency of Industrial Science and
Technology, Ministry of International Trade
and Industry
- Mr. Nagamasa KATAOKA : Course Leader of the Glass Technology Course
- Mr. Kazunori OSHIYAMA : Staff, Training Div.,
Osaka International Training Centre
Japan International Cooperation Agency

III. OBJECTIVE

The main purposes for the dispatch of the team are as follows:

1. to meet the ex-participants of the Glass technology Course and investigate the extent of the usefulness of the course collecting their opinions and suggestions, so as to improve the future programme of the course

2. to understand the present situation and technical level of the glass industry in Thailand, observing the major glass manufacturing plants which includes the ones where ex-participants work
3. to find the present needs of the glass industry in Thailand
4. to introduce to the ex-participants a new achievement of glass bottle manufacturing technology in Japan.

IV. SUMMARY OF DAILY SCHEDULE

March 27 (Tue.)	Arrival at Bangkok
March 28 (Wed.)	Visit to Japanese Embassy and JICA Visit to Siam Glass Industry Co., Ltd. Meeting with two ex-participants
March 29 (Thu.)	Courtesy call on Director - General, Dept. of Technical and Economic Cooperation Visit to Glass Organization Meeting with 7 ex-participants
March 30 (Fri)	Seminar on the glass technology at the Glass Organization Visit to Thai - Asahi Glass Co., Ltd. Dinner party by JICA Technical Follow-up Team at Indra Regent Hotel
March 31 (Sat.)	Visit to Ocean Glass Co., Ltd.
April 1 (Sun)	Report Making
April 2 (Mon)	Visit to Japanese Embassy and JICA Leave Bangkok

V. SUMMARIZED REPORT

1. Present situation of the glass industry particularly bottles and containers in Thailand:

We visited and observed four glass plants. Through this observation, we came to understand not only the present technical level of the industry which is making a rapid progress with some Technical Cooperation in the private Sector, but we also became aware of the variety of social background which helps us understand the industry in different aspects (wages, working condition, attitude of employer, etc.)

At the time of the observation, the undermentioned items were particularly studied by the team.

- (1) Raw materials and batch handing
- (2) Melting and forming
- (3) Testing and its facilities

2. Meeting with ex-participants:

There are thirteen ex-participants expected to meet in Thailand. The team met nine of them. Although two of them changed companies, all of nine are still working in the glass industry and each of them plays a very important role in the company.

The ex-participants that the team could not meet are:

- | | | |
|--------------------------|----------------|---|
| Mr. Amphorn Tongnuanoom | (1968 - 69)--- | his whereabouts unknown |
| Mr. Suwich Tontrakul | (1969 - 70)--- | his whereabouts unknown
and said to be the plant
manager of Jalapratana
Cement Co., Ltd. |
| Mrs Somsuk Sakulthongbai | (1972 - 73)--- | retired to the household
and whereabouts unknown |
| Mr. Komson Worapattrakul | (1983 - 84)--- | receiving training at a
private company in Japan |

Summarized opinions and suggestions of the ex-participants are as follows:

- (1) The training on The Glass Technology Course is useful and it's very recommendable to their colleagues.
 - (2) Ex-participants hope for the refresh training in Japan because many new achievements have been made since they attended the course.
 - (3) The latest techniques should be regularly introduced to the ex-participants by the closer contact with each other.
 - (4) As one of follow-up activities, some of ex-participants wish to have an audio visual materials sent by JICA, such as video tapes used for the training in some of Japanese companies.
 - (5) A subject on the management of glass manufacturing company should be added to the programme of the course because it differs from the management of other industries in many ways and is difficult to learn otherwise.
3. A seminar on "a new achievement in light - and - strong glass bottles" was held by the team at Glass Organization. The seminar was attended by ex-participants and the discussion was made at the end of the seminar.

VI. COMMENT

The followings comments are based on our impressions which are formed during our visits and meetings at various organizations in Bangkok.

- (1) Each of the nine ex-participants that we met have proved the usefulness of this training course more or less by playing a very important role in the company/organization.
- (2) As the nature of the group training course, it's impossible to make the course suit the purpose of each participant completely, however, the training course is still very helpful. To make the most of the opportunity, the participants of the course had better prepare a theme of his own to be solved in Japan before he attends the course.

- (3) The pace of the glass technology progress in Thailand is much faster than we expected. Taking into the consideration all the new adaptations of the technology from overseas, the future programme of the course will need some ammendments so as to suit the purpose of Thai participants better (by adding the subjects on computerization for example)
- (4) To improve the production efficiency, the total quality control should be needed in some case. The possibility of adding this subject to the programme should be considered.
- (5) Many questionings have been made in the discussion with the ex-participants. Some were answered at hand and the others remain to be answered later by correspondance. The team wishes that such communications could lead to a steady improvement and better understanding.
- (6) Meetings with ex-participants, officials and engineers in Thailand are very useful and beneficial to the team. We shall transmit their opinions/suggestions to the authorities concerned in Japan for further improvement of the group training course in Glass Technology.

April 7, 1984

JAKARTA

Dear Sir,

We have great pleasure of submitting herewith our Summary Report of the Technical Follow-up Team for the ex-participants of the Group Training Course in Glass Technology of JICA.

Since this training course has now fourteen years' history, there are more than a hundred ex-participants in all of twenty four countries throughout Far East, Southeast Asia, Southwest Asia, Mid-East, Near East, Egypt, Latin American, etc.

Among them, Indonesia has sent more than ten glass engineers to Japan to participate in the training course. Therefore, we took Indonesia as the theatre for the follow-up mission which was realized after long years.

Through the meetings held on this occasion, we received a good deal of kind suggestions from the Authorities concerned and ex-participants for further improvement of the training course.

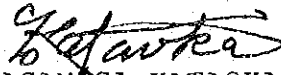
As described in our report, we would like to make our efforts in having your suggestions reflected in the future training programme.

We sincerely thank you very much for your kind and helpful cooperation.

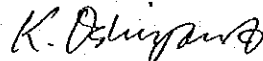
Yours faithfully,



JUNJI HAYAKAWA



NAGAMASA KATAOKA



KAZUNORI OSHIYAMA

Technical Follow-up Team,
Glass Technology, JICA

SUMMARY REPORT OF THE TECHNICAL FOLLOW-UP TEAM FOR JICA
EX-PARTICIPANTS OF THE GROUP TRAINING COURSE
IN GLASS TECHNOLOGY

I. Introduction

It is our great pleasure to have had the opportunity to visit Indonesia as the member of Technical follow-up team. After having completed all the schedule, the team submits herewith a summary report on its 6 days of follow-up activities for the reference of the officials of the authorities concerned in Indonesia.

At the same time, we should like to express our deepest gratitude for the warm welcome and kind cooperation extended to us during the whole period of our stay.

II. Team Member

Mr. Junji HAYAKAWA	Senior Research Engineer of 4th Department, Government Industrial Research Institute, Osaka Agency of Industrial Science & Technology, Ministry of International Trade & Industry
Mr. Nagamasa KATAOKA	Course Leader of the Glass Technology Course
Mr. KAZUNORI OSHIYAMA	Staff, Training Division Osaka International Training Centre Japan International Cooperation Agency

III. Objectives

The main purposes for the dispatch of the team are as follows:

1. To meet the ex-participants of the Glass Technology Course and investigate the extent of the usefulness of the course collecting their opinions and suggestions, so as to improve the future programme of the course.
2. To understand the present situation and technical level of the glass industry in Indonesia, observing the Ceramic Research Development Institute (CRDI) in Bandung and P.T. Iglas in Surabaya.

3. To find the present needs for the further development of the glass technology in Indonesia.
4. To introduce to the ex-participants a new achievement of glass bottle manufacturing technology in Japan.

IV. Summary of Daily Schedule

- April 2 (Monday) Arrival in Jakarta
- April 3 (Tuesday) Visit to JICA
Jakarta - Bandung
- April 4 (Wednesday) Visit to CRDI
Seminar on glass technology
- April 5 (Thursday) Meeting with ex-participants of CRDI
Introduction of GIRIO's activities
Laboratories observation
Bandung - Jakarta
- April 6 (Friday) Visit to Multifarious Manufacturing
Industries, Ministry of Industry
Jakarta - Surabaya
- April 7 (Saturday) Visit to P. T. Iglas
Plant observation
Meeting with ex-participants
- April 8 (Sunday) Surabaya - Jakarta
- April 9 (Monday) Leave Jakarta (for Manila)

V. Summarized Report

1. Present situation of the glass technology in Indonesia:

We observed CRDI and P. T. Iglas and studied the following items.

- (1) Raw materials and Batch handling
- (2) Melting and Forming
- (3) Testing and its facilities
- (4) Pending problems and difficulties in researches

2. Meeting with ex-participants:

There are eleven ex-participants expected to meet in Indonesia. The team met nine of them. All of nine are still working in the same plant/institution and each of them plays a very important role.

One of the two ex-participants, the team could not meet (owing to lack of time) is Mr. Soemantójo. He left P. T. Iglas and he is now working for Aneka Gas (Jakarta).

Another is Mr. Hardjodisastro Sudiharto of Planning Bureau, Department of Industry.

Summarized opinions and suggestions of the ex-participants are as follows:

- (1) The training in Japan is useful and it is very recommendable to their colleagues.
 - (2) Ex-participants want JICA to send the latest information magazine on the glass regularly.
 - (3) Ex-participants wish GIRIO to give a technical guidance to each of their problems (P.T. Iglas).
 - (4) Ex-participants wish to have a joint project with GIRIO such as a development project on a fiber glass, etc.
3. A seminar on "a new achievement in light-and-strong glass bottles" and an introduction of GIRIO's activities on glass was given at CRDI.

The seminar was attended by 62 participants and a certificate was awarded to all the attendants by CRDI. At the end of the seminar was a question-and-answer session between the lecturers and the participants. In this session, some of the questions were left to be answered later from Japan due to the amazingly active questionings.

VI. Comment

The following comments are based on our impressions which have been formed during our visits and meetings at various organizations in Indonesia.

1. P. T. Iglas in Surabaya has a long history in producing various types of glassware. Accordingly, three ex-participants have extended the knowledge which they gained during the training course in Japan.

More surprisingly, all of them now hold the highest posts in the plant.

Through the observation and the active technical discussion afterwards, we have learned they have enough testing equipments and high motivation for further development.

However, some more assistance will still be very helpful to them when it comes to the development of a new product.

2. Judging from the present trend of developing glass industry in the country and the great interest in glass technology which was shown by sixty-two attendants for the seminar held at CRDI, the role to be played by CRDI is obviously very important.

To serve this purpose, CRDI is expected to strengthen the glass section so that it can contribute to the setting up of Indonesian Industrial Standard.

3. As the nature of the group training course, it is impossible to make the course serve everyone's purpose. To make the most of the opportunity, the future participants had better prepare a theme of his own to be solved in the course of the training in Japan.
4. Some more supply of GIRIO/SRM (Standard Reference Material provided by Government Industrial Research Institute, Osaka) is eagerly wanted by the laboratory engineers who are engaged in the determination of physical and chemical properties of their products. By this, we confirmed its usefulness. Although a block of GIRIO/SRM has been handed out to every participant at his/her successful finish of the training in Japan since 1980, we made a promise to send some more to each laboratory on the return of the team.
5. Meetings with ex-participants, officials and engineers in Indonesia are very useful and beneficial to the team. We shall transmit their opinions/suggestions to the authorities concerned in Japan for further improvement of the group training course in Glass Technology Course.

April 13, 1984

MANILA

Dear Sir,

We have great pleasure of submitting herewith our Summary Report of the Technical Follow-up Team for the ex-participants of the Group Training Course in Glass Technology of JICA.

Since this training course has now fourteen years' history, there are more than a hundred ex-participants in all of twenty four countries throughout Far East, Southeast Asia, Southwest Asia, Mid-East, Near East, Egypt, Latin America, etc.

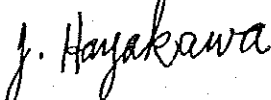
Among them, the Philippines has sent more than ten glass engineers to Japan to participate in the training course. Therefore, we took the Philippines as the theatre for the follow-up mission which was realized after long years.

Through the meetings held on this occasion, we received a good deal of kind suggestions from the Authorities concerned and ex-participants for further improvement of the training course.

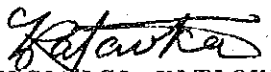
As described in our report, we would like to make our efforts to have your suggestions reflected in the future training programme.

We sincerely thank you very much for your kind and helpful cooperation.

Yours faithfully,



JUNJI HAYAKAWA



NAGAMASA KATAOKA



KAZUNORI OSHIYAMA

Technical Follow-up Team,
Glass Technology, JICA

SUMMARY REPORT OF THE TECHNICAL FOLLOW-UP TEAM
FOR JICA EX-PARTICIPANTS OF THE GROUP TRAINING
COURSE IN GLASS TECHNOLOGY

I. INTRODUCTION

It is our great pleasure to have had the opportunity to visit the Philippines as the member of Technical Follow-up Team. After having completed all the schedule, the Team submits herewith a summary report on its follow-up activities for the reference of the officials of the authorities concerned in the Philippines.

At the same time, we should like to express our deepest gratitude for the warm welcome and kind cooperation extended to us during the whole period of our stay in the Philippines.

II. TEAM MEMBER

Mr. JUNJI HAYAKAWA : Senior Research Engineer of 4th Department, Governmental Industrial Research Institute, Osaka, Agency of Industrial Science and Technology, Ministry of International Trade and Industry.

MR. NAGAMASA KATAOKA: Course Leader of the Glass Technology Course

MR. KAZUNORI OSHIYAMA: Staff, Training Division
Osaka International Training Centre
Japan International Cooperation
Agency

III. OBJECTIVE

The main purposes for the dispatch of the team are as follows:

1. To meet the ex-participants of the Glass Technology Course and investigate the extent of the usefulness of the course collecting their opinions and suggestions, so as to improve the future programme of the course

2. To understand the present situation and technical level of the glass industry in the Philippines observing the major glass manufacturing plants in which the ex-participants work.
3. To find the present needs of the glass industry in the Philippines.
4. To introduce to the ex-participants a new achievement of glass bottle manufacturing technology in Japan.

IV. SUMMARY OF DAILY SCHEDULE

- April 9 (Mon.) : Arrival at Manila
- April 10 (Tue.): Courtesy visit to NEDA
 : Visit to JICA
- April 11 (Wed.): Visit to Union Glass & Container Corp.
 (Observation & Discussion)
 : Visit to Republic Glass Corporation
 (Observation & Discussion)
- April 12 (Thu.): Visit to San Miguel Corporation
 (Observation & Discussion)
 : Seminar on the Glass Technology
 : Evaluation meeting with the ex-participants
- April 13 (Fri.): Report making
 : Visit to JICA
- April 14 (Sat.): Leave Manila (for Osaka)

V. SUMMARIZED REPORT

1. Present situation of the glass technology in the Philippines:

We observed each plant of Union Glass & Container Corp., Republic Glass Corp. and San Miguel Corp. and studied the following items.

- (1) Raw materials and Batch handling
- (2) Melting and Forming
- (3) Testing and its facilities

2. Meeting with ex-participants:

There are eleven ex-participants expected to meet in the Philippines. The team met eight of them. All of eight ex-participants are working for the same company and each has been promoted and holds a very important post. Summarized opinions and suggestions from them are as follows:

- (1) The training in Japan is useful and it is very recommendable to their colleagues.
- (2) Ex-participants want JICA to send the latest information on the glass technology.
- (3) Ex-participants hope for the refresh training in Japan because many new achievements have been made since they attended the course.

The ex-participants whom the team could not meet are:

- . Mr. Luis S. Manzano (1969-70)
An ex-employee of Union Glass & Container Corp. and working in the different line (pipes & furniture manufacturing)
- . Mr. Flores Magtangol C. (1972-73)
An ex-employee of National Institute of Science and Technology and working for one of national institutes in Mexico.
- . Mr. Renato Severo F. Tomires (1974)
An ex-employee of NIST and presently out of communication.

3. A seminar on "a new achievement in light-and-strong glass bottles" was held by the team.

The seminar was attended by ex-participants and followed the discussion.

VI. COMMENT

The following comments are based on our impressions which are formed during our visits and meetings at various organizations in the Philippines.

- (1) All of the eight ex-participants that we met have proved the usefulness of this training course more or less by playing a very important role in each company.

- (2) San Miguel Corporation represents the container glass industry of the Philippines both in quality and in quantity and is well competitive with the container glass companies in most advance countries.

San Miguel Corporation has its own technical training school in which the ex-participants of JICA group training course make themselves lecturers.

One of the ex-participants was promoted up to a responsible plant manager of the newly constructed Cebu-plant.

Our team was very pleased to have learned that the ex-participants were making the best use of what they had gained from the training in Japan.

- (3) It seems that some of the ex-participants are in need of the broader knowledge (beyond their specialties), e.g., the correlation between batch handling and furnace operation.

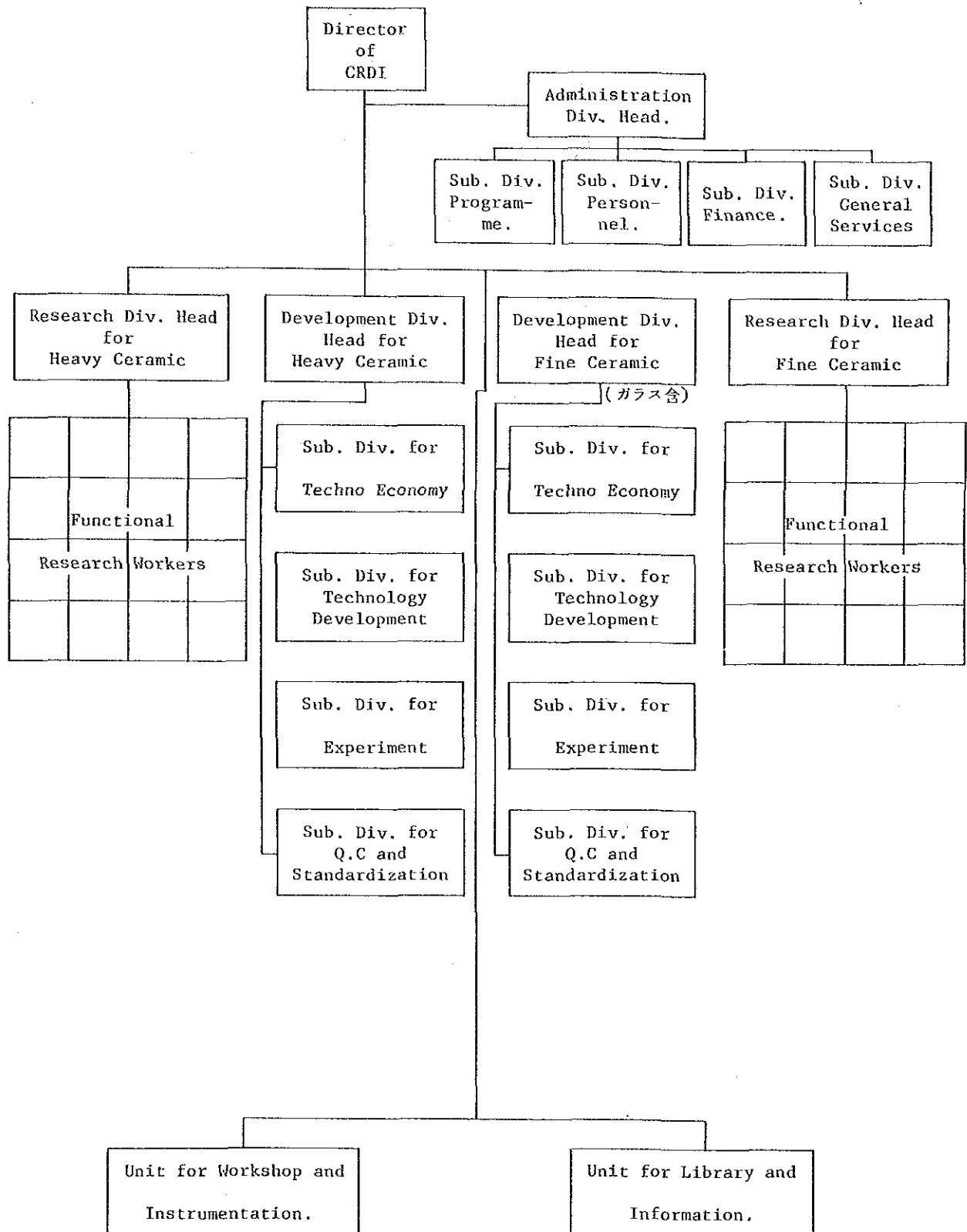
The lectures on such correlations will possibly be included in the future program of the training course.

- (4) Screening of applicants for this group training course is performed well by the committee through National Economic and Development Agency (NEDA). The request of earlier distribution of "General Information" was suggested by NEDA. The team will transmit this to the authorities concerned in Japan.

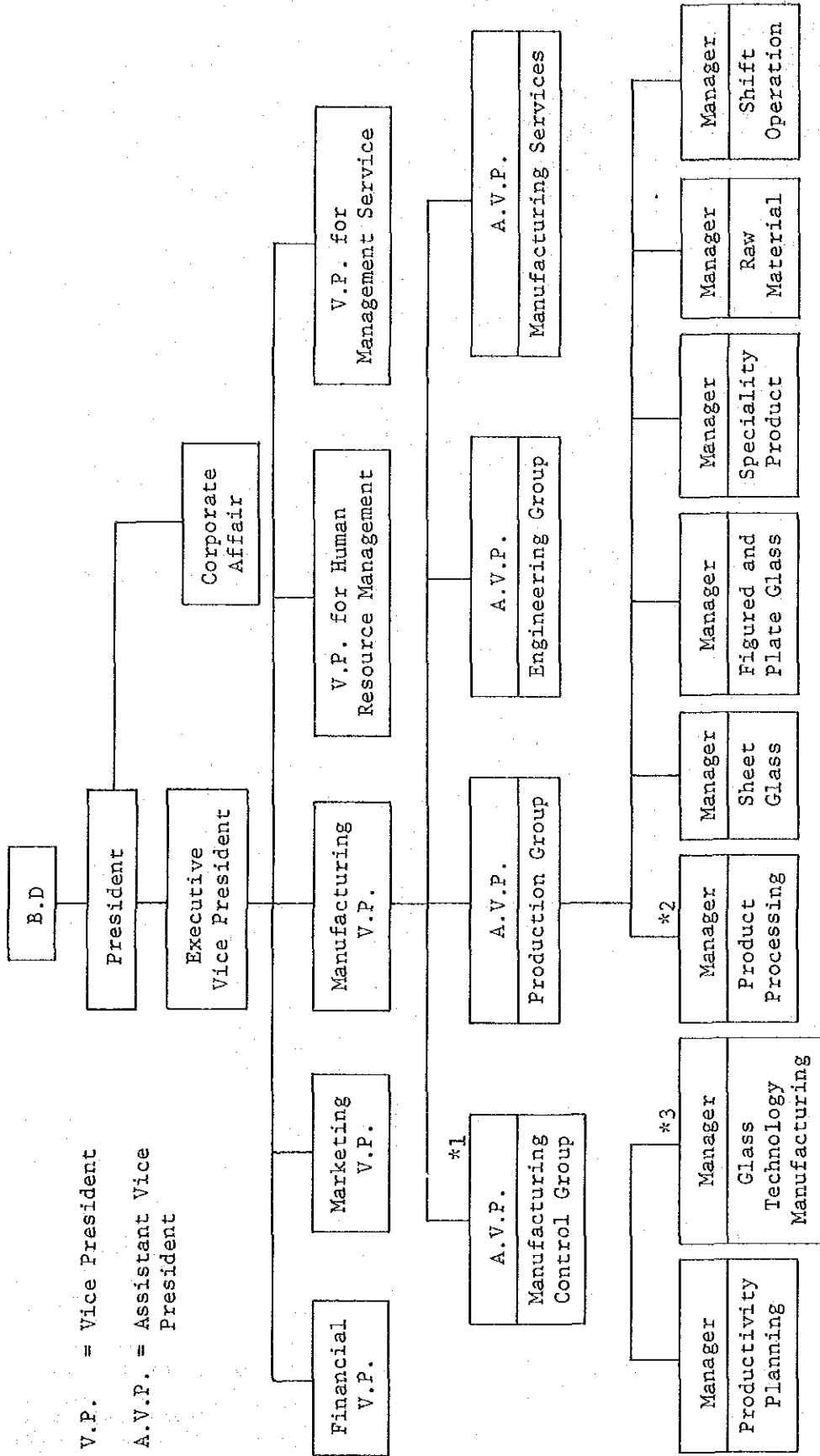
- (5) As the nature of the group training course, it is impossible to make the course suit the purpose of each participant completely, however, the training course is still very helpful. To make the most of the opportunity, the participants of the course had better prepare a theme of his own to be solved in Japan before he attends the course.

- (6) Meetings with ex-participants, officials and engineers in the Philippines are very beneficial to the team. The team shall transmit their opinions/suggestions to the related authorities for further improvement of the group training course in Glass Technology.

(資料3-1) CRDIの組織図



(資料 3 - 2) REPUBLIC GLASS CORPORATION の組織図



V.P. = Vice President

A.V.P. = Assistant Vice President

- *1 Mr. Richard A. Roxas
- *2 Mr. Rosalito Lito Dominguez
- *3 Mr. Roberto G. Agustin

LIGHT AND STRONG GLASS BOTTLES CONSERVE
MORE RESOURCES AND ENERGY

A Noticeable Achievement of Glass Bottle Manufacturing Technology in Japan.

N. KATAOKA, J. HAYAKAWA, and K. OSHIYAMA

Follow-up Mission for The Training Course
in Glass Technology of JICA/CIRIO.

MARCH 1984

- (1) In a practical sense, glass containers are,
- 1) Chemically durable,
 - 2) Impermeable to any gases and odor,
 - 3) Washable and returnable,
 - 4) Hard enough to keep foods in them,
 - 5) Transparent to observe contents in them, but,
 - 6) Heavy and fragile compared with other containers such as plastics, paper bags, carton, etc.

If we can reduce the weight of glass bottles & containers without reducing their mechanical strength, their properties are not only superior to other vessels made of the materials mentioned above, but also they bring us beneficial effects on the conservation of raw materials and energy for the melting, handling as well as the transportation of glassware.

Reducing weight for the same capacity of a bottle will naturally bring about thin wall thickness with increased fragility. So, the light-weight bottles must be strengthened anyhow. This aim was achieved successfully for the first time in mass production by Yamamura Glass Co., Ltd. of Japan in 1975.

- (2) To reduce the weight of bottles, Dr. H. Ono and his colleague considered following items:

- 1) Change in the forming techniques,
- 2) Change in shape of bottles,
- 3) Coatings for protecting bottle surface,
- 4) Chemical strengthening of glass.

There are three major systems for the mechanical forming of bottles, namely, B.B. (Blow and Blow), P.B. (Press and Blow), and N.N.P.B. (Narrow Neck Press and Blow).

More uniform thickness of the bottle is obtained by P.B. system, however, broader contact area of the plunger with the internal surface of bottle leaves problem on the strength of the products. Relation between the condition of the plunger and the strength of the products has been thoroughly investigated by R & D members of YGC. (New Glass Technology, Vol.2, No.4, 35-45, 1983)

Empirical formulas relating to the minimum thickness, T_m , designed thickness, T , of wall and outer diameter, D , of the bottles were also obtained as follows:-

For B.B. system (n=40),

$$T_m = 0.749T - 0.011D - 0.493 \quad \sigma = 0.197$$

P.B. system (n=40),

$$T_m = 1.013T - 0.013D + 0.032 \quad \sigma = 0.126$$

N.N.P.B. system (n=15),

$$T_m = 0.601T - 0.0162D + 1.330 \quad \sigma = 0.153$$

Further investigation as to where T_m appears at in the bottles was reported as follows:-

SPOTS WHERE T_m APPEARS AT

System	Shoulder	Gobline	Heel
B.B.	35	65	- %
P.B.	23	-	77 %
N.N.P.B.	93	-	7 %

Before the chemical strengthening treatment, bottles should be prepared with cautions shown below as far as possible:-

- 1) Faultless internal surface which improves impact strength,
- 2) Uniform side wall thickness which improves resistance to the internal pressure and thermal shock,
- 3) Surface condition of the plunger must be checked.
- 4) Lubricant application to the plungers must also be carefully controlled.
- 5) Well-digested homogeneous melt which improves impact strength.
- 6) Quality-controlled batch handling and cullet processing are of great importance.

After a strenuous Research & Development activity, YCC substantiated their own process of the treatment & facilities for the chemical strengthening of bottles, and made a wonderful progress year by year in the lightening weight and reducing thickness of their products as shown in Fig. 1.

Mechanism of the chemical strengthening, as itself, is known as the ion exchange in which sodium ions in glass migrate into the melt containing potassium ions, and reversely the potassium ions in the melt enter in place of sodium ions in the glass at elevated temperature.

When cooled down to the room temperature, surface layers, both inside and outside, are subjected to compression.

Physical phenomenon resulted herein is quite similar with that of the tempered sheet glass which is widely used in architecture, automobile, etc. Glass bottles and containers are not so simple as sheet glass in their shape that the tempering method cannot be applied effectively to bottles, particularly in case of thin wall thickness.

Fig. 2 shows simplified schematic 2D structures of alkali silicate glasses. Cause of the compression in the surface layers is due to the difference in diameter between sodium ion (1.94Å) and potassium ion (2.66Å), and the contraction of internal layer.

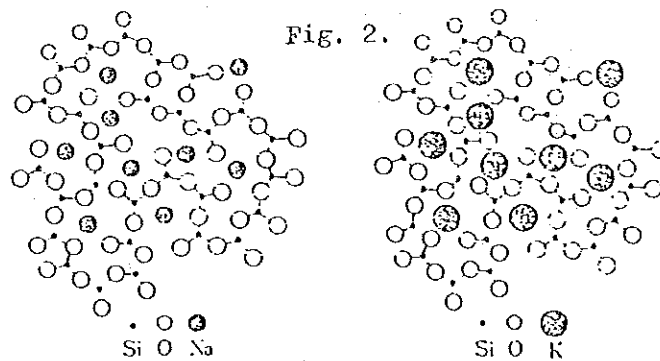
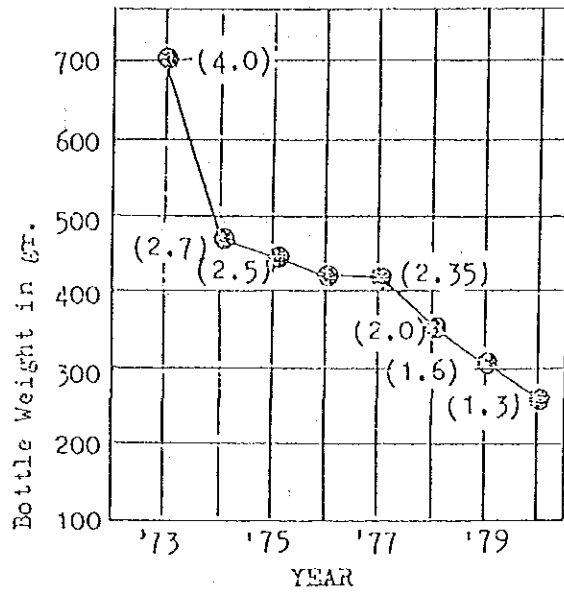


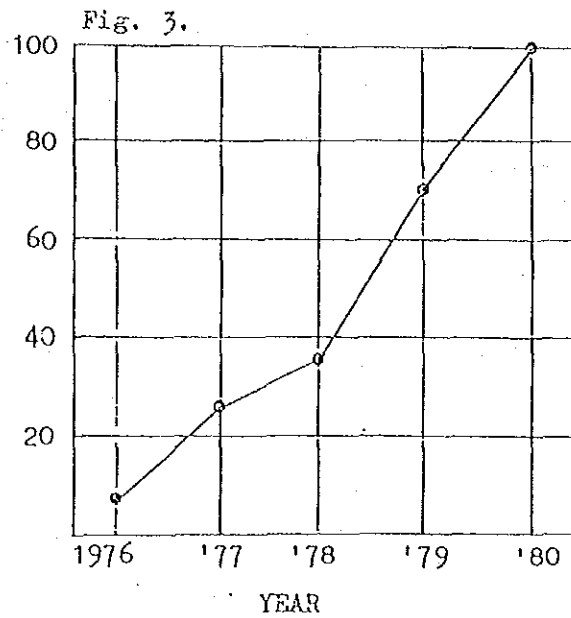
Fig.2. Simplified schematic 2D structures of the layer before and after ion exchange.

Fig. 1.



The Progress in Lightening 1 Liter CST One Way Bottle (1973 - 1980).

Figure in parenthesis shows side-wall thickness in mm.



Sales of CST[®] Bottles (in million bottles).

Table 1. Weight Reduction and Strength of CST[®] Bottles.

Content	Capacity (ml)	Weight			Strength of CST [®] bottles	
		CST [®] Bottle (gr)	Standard Bottle (gr)	Reduction Ratio (%)	Internal Pressure Resistance (psi)	Impact Strength
Cola	1000	580	740	Δ 21.6	650	34.4 lb-in
Orange Ade	1000	395	650	Δ 39.2	464	12.4 lb-in
Sake	1800	535	1050	Δ 49.0	396	10.0 kg-cm
Sake	1800	450	1050	Δ 57.1	330	8.0 kg-cm
Sake	900	350	450	Δ 22.2	456	8.3 kg-cm
Orange Juice	1000	305	700	Δ 56.4	435	10.4 kg-cm
Soy Sauce	1000	265	700	Δ 62.1	364	7.8 kg-cm

Table 1 shows the weight reduction ratio and the strength of chemical strengthened YGC bottles, and Fig. 3 shows how the lightened and strengthened bottles have been accepted by the market.

(3) Energy Saving.

Fig. 4. Trend of Energy Consumption per One Ton of Glass.*

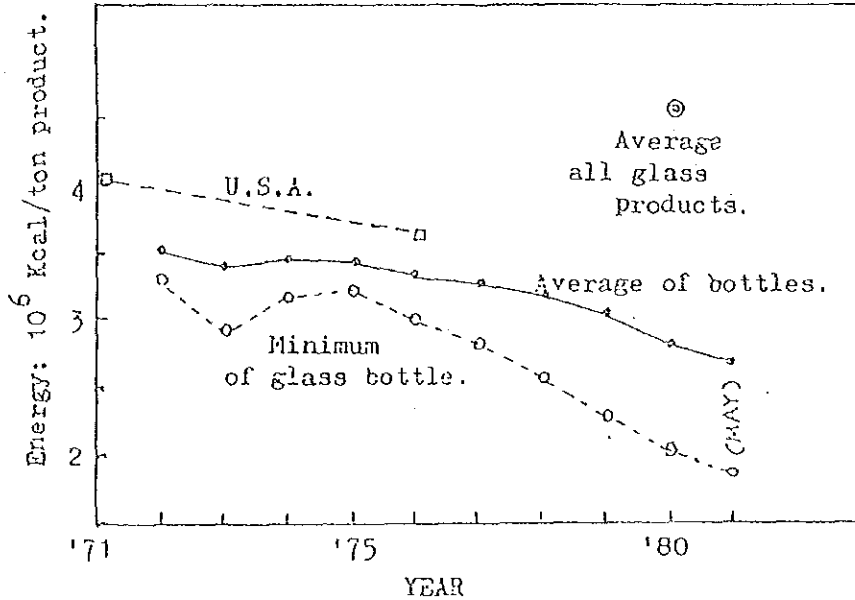


Table 2. Targets in the Future.

FUTURE RADIATION QUANTITY OF HEAT FROM VARIOUS PARTS OF THE FURNACE AS OF PRESENT, (%)*

Bottom (Melting)	40	Breast wall (Melting)	15
Bottom (Working)	35	Breast wall (Working)	25
Side wall	65	Back wall	15
Tuckstone (Melting)	15	Crown (Tank)	20
Tuckstone (Working)	25	Crown (Regenerator)	50
Port wall	15	Wall (Regenerator)	40
Port crown	33		

*New Glass Technology, Vol.1, No.3, 9-14, 1982.

JICA