INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION, INC.

GALFAN TECHNOLOGY CENTER

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MEMORANDUM

TO: All Galfan® Licensees

FROM: John L. Hostetler

DATE: 4 January 1995

SUBJECT: Galfan Licensee Meeting Proceedings

A copy of the Proceedings for the 1994 Galfan licensee meetings is enclosed. We are using a revised database which shows your name as the official Galfan license representative for your company. If corrections are required, please fax them to GTC as quickly as possible since this is the database from the 1995 Galfan Directory listings.

Yours is the only copy sent to your company. If additional copies are needed, please fax your request to GTC. A nominal charge will be invoiced to you to cover shipping and handling costs.

The 1995 Galfan Directory is scheduled for mailing at the end of January. Galfan Production Reports and Forecasts for 1994 will also be mailed at the same time. The GTC budget for postage and mailing requires us to restrict general mailings to one addressee per license to allow more communication from GTC.

There are many encouraging signs to predict a successful 1995 for Galfan. Those signs and the trends for the year should be well established by the time we meet in June at West Point, New York. I hope you are planning to be there.

JLH:ja

Encl.

GALFAN®
IMPROVED GALVANIZING

19th

LICENSEE MEETING PROCEEDINGS

Kobe, Japan - Dearborn, MI USA - Luxembourg
Oct. 18, 26, Nov. 4, 1994

Sponsored By:

International Lead Zinc Research Organization, Inc.
GALFAN Technology Center
Research Triangle Park, NC USA

EXPLANATIONS

Regional Meeting Format

This year's Galfan® licensee meetings were held as regional meetings in Kobe (Japan), Dearborn (N. America) and Luxembourg (Europe). Licensee responses to the meeting questionnaire last year were strongly in favor of regional meetings in alternating years in order to increase attendance by reducing the cost of travel.

Another change made based on the responses was to limit attendance to licensees. Licensee attendance at the three regional meetings was about the same as the last three world-wide meetings but seemed less because the attendees were in three separate groups and the 20 to 25 suppliers were not there.

There are certain logistic problems to the regional format. Regional meetings will probably work better if a Galfan Development Association is active and able to organize the meeting. With the experience of 1994's meetings to add to our knowledge, we will discuss the entire meeting format again in West Point in June.

Proceedings Format

Most of the reports were repeated at the three meetings. The proceedings in the Kobe and Dearborn meetings do not include the reports which were repeated in Luxembourg.

We experienced a lack of reports and papers, partly because some licensees asked to wait until the West Point meeting. Secondly, there were no active major research projects to report on. With the advent of GTC-sponsored research in the future, there will be more reports, particularly to GTC unitholders.

RESPONSE SUMMARY
TO LICENSEE MEETING QUESTIONNAIRE

1. Which of the last four licensee meetings did you or someone from your company attend?

[12] July, 1990 Liege, Belgium (1) [13] Oct, 1991 Pittsburgh, PA (2)
[14] Oct, 1992 Tokyo, Japan (1) [15] Oct, 1993 Linz, Austria (2)

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2. What kind of meeting do you think is most helpful?

[3] Annual world-wide [4] Annual regional
[18] Alternating; world-wide in odd years, regional in even years
[2] Worldwide every 2 years

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3. What kind of agenda do you find most helpful?

[15] Research Reports [18] Operating Reports
[12] Marketing Reports [2] Process technology

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4. How helpful is a plant tour?

[1] No help [9] Some help [15] Very helpful

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5. Would you add an extra day to your trip for a plant tour?

[20] Yes [3] No

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6. What kind of group sessions are most helpful to you?

[6] Combined - sheet, wire and tube
[8] Completely separate meetings for (a)sheet, (b)wire, and (c)tube
[9] Combination - some general sessions, some separate but at same time

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7. Do you think sessions should be restricted?

[12] no, should be open to anyone who can contribute something
[11] yes, to licensees only (no suppliers or research contractors)
[0] yes, to actively producing licensees only

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8. How do you prefer the meeting's registration fee to be assessed?

[20] Separate from the accomodations (as it has been)
[2] Combined with the standard rates for accommodations

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9. How do you rate the importance of a social event as part of the meeting?

[14] It's nice - it adds to the experience
[9] It makes no difference - I can take it or leave it

Revised Mar. 17 1994

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Minutes of the

Japanese Galfan Licensee Meeting

Held at

The Portopia Hotel
Kobe, Japan

October 18, 1994

ATTENDANCE:

Name	Company
Fujikawa, M.	Mitsui Mining & Smelting Co., Ltd.
Fukushima, Y.	NKK Corporation
Hiraishi, T.	Kawatetsu Galvanizing Co., Ltd.
Hostetler, J.	ILZRO/GTC
Kobayashi, E.	Kawatetsu Galvanizing Co., Ltd.
Konishi, J.	Mitsubishi Materials Corporation
Nakamura, H.	Kakogawa Works, Kobe Steel, Ltd.
Oshima, K.	Wakayama Steel Works/Sumitomo Metal Ind.
Takase, A.	NKK Corporation
Tanaka, H.	Yodogawa Steel Works, Ltd.
Yoshii, F.	Yodogawa Steel Works, Ltd.

Discussion Re: Japan Galfan Development Association:

Mr. Hostetler asked the attendees to consider the formation of an association of Galfan licensees in Japan. The general purpose of such an association would be to generically promote the knowledge and use of Galfan products in Japan.

Two more immediate objectives were also suggested:

1. Improve the quantity and quality of communications, especially technology transfer, between the licensees and GTC.

2. Translate and publish important GTC documents into Japanese language.

Mr. Hostetler pledged support for such an association. Several possibilities for support were suggested and discussed briefly, including:

1. GTC could appoint a technically qualified Galfan Technology Representative who has very good English language skills.

2. Participate in one meeting each year (other than the licensee meeting) organized and sponsored by the association.

3. Compile, develop and publish technical information to support generic sales and marketing for specific market or end-use applications of Galfan products.

Discussion Re: GTC Research Committee:

The role of the GTC Research Steering Committee was of particular interest to the attendees. Discussion relating to the function and qualifications of the regionally elected steering committee member went beyond the content of the published GTC Business Plan or the GTC Operating Policy Manual. Conclusions reached include:

1. The regional committee member's *function* is to help the steering committee make meaningful decisions relating to the use of the GTC research budget. This includes prioritizing nominated research projects, defining the work scope and objectives of each research project and approving all research contracts.

2. The regional committee member does this first by representing the GTC shareholders in his or her region. The regional member becomes the region's vote on the steering committee in all committee-decided matters.

   When the steering committee votes to sponsor a project, the total management of that project is sub-contracted to ILZRO. Thus it is expected that all projects submitted to the steering committee for final approval shall be in the standard ILZRO venture analysis format based on proposals from qualified research contractors.

3. Second, the member reports for the steering committee to the GTC shareholders in his region. Although the creation and distribution of the formal research reports are the committee chairperson's responsibility, the regional member shall be prepared to explain, justify and defend the research information.

4. The ideal candidate for regional member of the steering committee will have the following skills and experience:

   a) possess good English language skills,
   b) have a scientific research education and experience,
   c) have experience with Galfan or hot-dip galvanizing,

d) be readily available to the committee chairman via fax and
e) be available to attend world-wide and regional GTC meetings.

Mr. Konishi gave several arguments why he thinks the regional member should be a GTC shareholder who is an active sheet, wire or tube licensee rather than an alloy licensee shareholder. The wisdom of having a majority of the committee made up of producing members is easily seen but it may also be wise to include an alloy licensee shareholder. The provision allowing the committee chairman to select an at-large member offers an opportunity to do that.

The regional committee member shall serve for two years. Selection of regional committee members shall be done at world-wide GTC meetings (scheduled for the odd years starting in 1995). Their term shall begin on Jan. 1 of the year following the GTC meeting but they should be available to meet with the out-going members immediately following the GTC meeting.

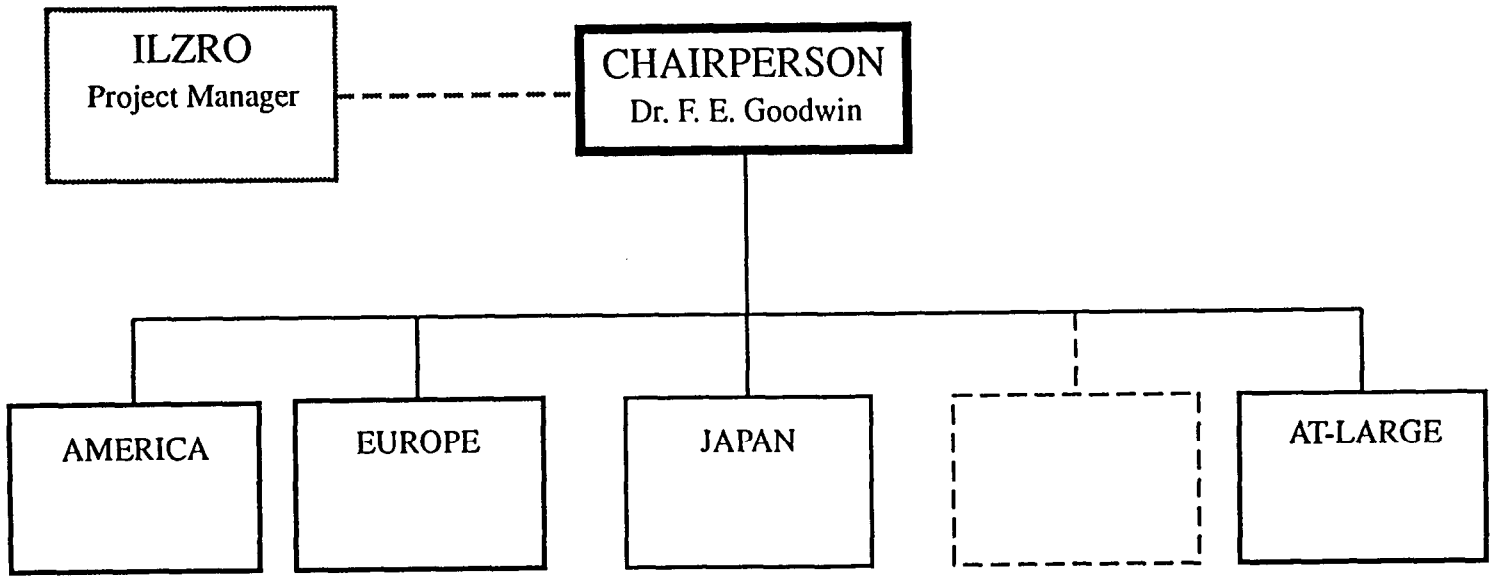
World-wide GTC meetings will probably follow the schedule below.

1995	June 19-21	West Point, New York, USA
1997	June	Japan
1999	June	Site in Europe to be selected

FLOW CHART: GTC-SPONSORED RESEARCH PROJECTS

1	NOMINATE RESEARCH PROJECT	Any GTC Unit Shareholder may nominate a research project to GTC Research Steering Committee for GTC sponsorship.
2	RFP TO QUALIFIED CONTRACTORS	Committee Chairperson prepares *Request For Proposal* and forwards to qualified research contractors.
3	EVALUATE PROPOSALS	Committee Chairperson evaluates proposals submitted for compliance to RFP.
4	DISTRIBUTE EVALUATION	Chairperson's *Evaluation Report* is distributed to GTC Research Steering Committee members for comments.
5	PREPARE VENTURE ANALYSIS	Chairperson prepares Project Venture Analysis to describe the project's context, scope, time line, cost and recommended research contractor.
6	DISTRIBUTE VENTURE ANALYSIS	Chairperson distributes *Venture Analysis and ballot* to GTC Unitholders for voting.
7	UNITHOLDERS ESTABLISH PROJECT'S PRIORITY	GTC Unitholders vote on the project to determine priority rating of the project.
8	COMMITTEE VOTES PROJECT APPROPRIATIONS	Chairperson calls meeting of the committee to decide on appropriations for projects based on Unitholders priority and GTC budget forecast.
9	CONTRACT AWARD	Chairperson prepares contract with ILZRO to manage the approved and sponsored projects.
10	RESEARCH WORK IS CARRIED OUT	ILZRO awards contract to research contractor. Project is managed by ILZRO. Contractor submits timely Progress Reports.
11	PROGRESS AND FINAL REPORTS	Research Contractor submits final report. ILZRO manager copyrights report and writes Executive Summary. *Progress Reports and Final Report* distributed to GTC Shareholders.
12	EXECUTIVE REPORT	*Executive Summary* distributed to all Galfan licensees.

GTC RESEARCH STEERING COMMITTEE



REGIONAL COMMITTEE MEMBERS

Selected by GTC Unit Shareholders in each region at world-wide GTC meetings.

AT-LARGE MEMBER

Appointed by Committee Chairperson. Serves same term as regionally elected members.

Minutes of the

Americas Galfan® Licensees Meeting

Held at

Dearborn Hyatt
Dearborn, Michigan, USA

October 27, 1994

ATTENDANCE:

Name	Company
Allen, Colin	Cominco
Aufderheide, Howard	Wheeling-Pittsburgh Steel
Brinsky, Jim	Weirton Steel
Burkholder, Joe	Handy & Harman
Capul, Tony	Weirton Steel
Elser, Phil	Indiana Steel & Wire
Hostetler, John	ILZRO/GTC
Hunt, Frederick	Florida Wire & Cable
Lester, Brian	Weirton Steel
Malmgreen, John	Eastern Alloys
Nielsen, Paul	Handy & Harman
Patel, R.D.	Form-Rite
Regan, Bill	Handy & Harman
Rendos, John	Wheeling-Pittsburgh Steel
Skubik, George	Eastern Alloys

Discussion Re: GTC Business Plan:

The discussion covered many features and aspects of the plan but the greatest concern expressed by the active sheet and wire licensees focused on (1) the relationship between Galfan licensees who buy a GTC unitshare and those who choose not to, and (2) the relationship between ILZRO and the Galfan licensee who chooses not to buy a GTC unitshare.

Mr. Hostetler said that two comments need to be made before responding to any questions.

First, the GTC plan anticipates that all active Galfan licensees will want to buy GTC unitshares but it does make allowances for licensees, both active and inactive, to choose not to.

Second, ILZRO intends to fulfill all its obligations specified in the Galfan license so long as the license is in force.

Specific questions of relationships were then discussed.

Question 1: *What is different about the information supplied by ILZRO to a Galfan licensee who buys a GTC unitshare and one who chooses not to?*

The primary difference relates to research. GTC's objective is not to do research but to generate the funding for Galfan research because *most Galfan technology is the product of Galfan research.* The GTC Research Steering Committee shall manage the GTC research budget. GTC-sponsored research shall be managed by ILZRO as regular ILZRO projects with GTC as the only Unit Shareholder therefore GTC is the sole owner of the research. Research implies *activities aimed at the discovery and interpretation of something new or the revision of theories or laws.*

The Galfan license stipulates that ILZRO and Licensee shall promptly notify one another of the existence of any Improvement known to them, and shall disclose to one another any and all technical information with respect to said Improvement. The Improvement referred to is related to the license's Agreement Field, which means the ILZRO alloy, procedures for applying the ILZRO alloy to metal products (sheet, wire or tube) as a galvanized coating, and metal products coated with ILZRO alloy.

Technical information implies *special and practical information of a process or equipment.*

In other words, the Galfan license requires that ILZRO and each licensee exchange any special and practical knowledge they have of any process or equipment that improves

galvanizing metal products with Galfan. Research on the other hand, are those activities that precede (and hopefully produce) such special and practical knowledge.

All Galfan licensees will receive technical information such as the current Galfan Technology documents, Executive Summaries of GTC-sponsored research projects, and published papers and reports concerning Galfan that are known and available to GTC.

Progress reports for GTC-sponsored research projects shall be available only to Galfan licensees who buy a GTC unitshare. The reports are not available to licensees who are not GTC shareholders. Moreover, the GTC shareholders from each region shall elect a representative of a GTC shareholder in that region to serve as a member on the GTC Research Steering Committee and thus have a voice in determining how GTC research resources are used.

Question 2: *What happens if a 1995 GTC shareholder chooses not to buy a unitshare for 1996?*

Mr. Hostetler: This is one of those situations we know is likely to happen but we have not yet developed a policy for it. My first reaction is that the shareholder is entitled to only the shareholder benefits completed by the end of 1995. The licensee would not be entitled to any research information from 1996 unless the licensee buys a 1996 unitshare before a renewal deadline date.

Question 3: *What happens if a licensee does not buy a 1995 unitshare but decides later to buy a 1996 unitshare?*

Mr. Hostetler: This falls into the same category as the previous case. Again, the first reaction is to limit all benefits to the unitshare years. The 1996 shareholder should get prior research reports.

Remember also that the GTC research is funded by new license fees, not unitshare income. The new licensee should therefore get all the research reports published through the end of his unitshare year.

Question 4: *What will be the status of NAGDA members who supported the "Galfan Buried in Soil and Concrete Study " in its first year? Will they get copies of each year's report if they are not a GTC shareholder? NAGDA members put a lot of effort in getting the project started with ILZRO stating that funding would be forthcoming for years two through five. As President of NAGDA, I am concerned that ILZRO may be backing away from promised support of our organization. (A question from Phil Elser, President, NAGDA)*

Mr. Hostetler: This is an unusual situation but I don't think the policy will be difficult to establish. The completion of this project must have a high priority with the GTC Research Steering Committee so I think it is safe to expect the Committee will fund it from the GTC research budget. Certain NAGDA members contributed over $25,000 to fund the first year's cost so NAGDA should be a unit shareholder in the project and would be entitled to the research information. I would think however, that NAGDA's distribution of that information should be limited to the licensees who contributed to the project's support. This is a case where GTC will not be the exclusive shareholder. I am sure there will be other similar cases.

JLH:ja

Minutes of the

European Region Galfan® Licensees Meeting

held at

Hotel Intercontinental
Luxembourg

November 4, 1994

ATTENDANCE:

Name	Company
Bechem, W.	BREGAL
Beguin, P.	Union Miniere
Blondeau, J-P	SOLLAC
Bourgeois, P.	Haironville
Dewitte, M.	Bekaert
Drake, S.	Tinsley Wire (Sheffield) Ltd.
Dubois, M.	Cockerill Sambre SA
Gailliez, B.	FFM
Goodwin, F.	ILZRO
Grandjean, P.	Union Miniere
Havrda, M.	HoMa (ILZRO/GTC)
Heiler, Hans-J.	Thyssen Stahl AG Werk Finnentrop
Hennechart, J-P	SOLLAC
Hogan, J.	ILZRO/GTC
Jacque, J.	TrefilARBED
Jore, T.	Norzink
Kavanagh, P.	British Steel
Lankila, A.	Rautaruukki
Naylor, J.P.	FFM
Nünninghoff, R.	University Wuppertal/TrefilARBED
Pankert, R.	Union Miniere
Payne, D.	Bridon Int.
Pelini, L.	Cockerill-Sambre SA
Sivula, J.	BREGAL
Warnecke, W.	Thyssen Stahl

MEETING CONVENED:

This meeting was convened by Dr. Goodwin who welcomed the group to the meeting and gave the proposed agenda for the day. He noted his presence in the meeting was due to the recent illness of Mr. Hostetler who was expected to recover shortly. He then asked each attendee to introduce himself to the group after which an attendance roster was circulated.

TECHNICAL PRESENTATIONS:

1. Galfan Corrosion Data — Bekaert:

Dr. Dewitte presented this report, noting that it was a view of the corrosion mechanism of Bezinal®, Bekaert's trademark for Galfan-coated steel wire. They have done indoor laboratory tests with both galvanized wire and Bezinal and compared the results. Outdoor exposure tests have also been carried out to determine the different life expectancies of zinc and Bezinal. The very effective cathodic protection of Bezinal in welded mesh has also been determined. This report will explain how the 95% Zn-5% Al has a two times higher corrosion resistance compared to a pure zinc coating.

Bekaert ran a six-year higher corrosion test at Ravensburg, Germany using highway fencing. Twenty-five percent (25%) of the original coating weight was lost after this period with 240 g/m^2 being left. A gray-black patina was also observed, however a smooth surface remained. Dr. Dewitte recalled the result of the Nisshin Steel paper presented last year at the Tokyo Licensees Meeting. These results were from a 10-year exposure program on sheet, using four different sites in Japan: 1)rural; 2)industrial; 3)severe marine; and 4)marine sites. Initially there were few differences in the corrosion rates of Galfan and galvanized sheet. A few years were taken to see the difference. Galvanized coatings were found to corrode in a linear fashion whereas Galfan had a parabolic corrosion curve. Also, red rust was seen on galvanized steel after some time, whereas Galfan had further corrosion protection from the presence of the Fe-Zn-Al layer.

Reviewing the Bezinal wire results, in the marine environment the galvanized wire was reduced to zero coating thickness after seven years after initially beginning with 50 microns of coating. Galfan still had at least 20 microns left under these same conditions. On the barbs, a similar condition was seen except there was a more severe situation. In the rural environment, a 50 micron coating thickness was also the starting point. This was reduced to 10 microns after eight years for galvanized and 30 microns for Galfan. The results were comparable in this way for exposures up to seven years. Dr. Dewitte explained the better corrosion performance of Galfan compared to galvanizing by noting the following:

1. The electrochemistry of the different coatings. The same voltage readings, around -1030 mV, are seen in oxygen-flushed seawater potentiostat cells for both zinc and Galfan. However, the corrosion current for Galfan is five times less than for Bezinal. This shows its greater passivity.

2. A parabolic trend of coating loss is seen in salt spray testing which confirms previous work of Nisshin.

3. Aluminum surface enrichment of the Bezinal coating has been observed by scanning Auger sputtering and analysis. Surface enrichment is seen in the top one-half micron thick layer. They have also looked at samples before and after the six-year exposure at Ravensburg and find the same trend.

4. There is a contribution to corrosion resistance of the "residual" coating, which is the intermetallic layer and overlaying corrosion products. In Bezinal, corrosion only starts when 3 microns of this residual layer is left, whereas with galvanizing it starts when 15 microns is left.

5. Efficient corrosion protection of welds in welded mesh is seen with Bezinal compared to galvanized. Early failure, defined as red rust, occurs with the galvanized mesh. Dr. Dewitte explained this phenomena by showing the Fe-Zn phase diagram. The melting point of the different alloy layers for Fe-Zn range between 600 and 700°C. Because the welding temperature is greater than 1,000°C, the alloy layer is believed to melt away, resulting in poor protection.

Galfan layer, by contrast, can be described using the Fe-Al phase diagram. The melting points of these intermetallics are 1,100-1,200°C, so perhaps they are not removed to the extent that they are with galvanized wire.

Dr. Goodwin asked about the parabolic relationship, noting that it had certainly been shown for the Nisshin Steel results and for the Bekaert salt spray results. However, he noted that they were not as pronounced for the Bekaert long-term results. Dr. Dewitte noted that it is clear that after five years there is a parabolic vs. linear relationship, however not for the first few years.

In response to a question by Dr. Goodwin regarding analysis methods, he noted that they check their coating weight loss results both by dissolution of the coating and by metallographic cross-sections. Dr. Goodwin also noted that the boiling point of zinc is around 920°C and therefore this is another reason why the intermetallics might be providing such poor protection in the galvanized metal mesh weld areas.

Mr. Dubois asked if the samples shown for Bezinal were single or double dip. Dr. Dewitte replied that they were double-dipped. They see a much thicker intermetallic layer than with sheet and find it favorable for corrosion performance. Mr. Dubois noted that they have seen very long stripping times required for samples having thick intermetallic layers in Galfan. They find that it helps restrict the amount of corrosion. Mr. Dubois asked further if different fume generation quantities were seen with Bezinal vs. normal galvanized wire during welding. Dr. Dewitte noted that fumes are seen in all cases, however the gray patina in Galfan appears to give more fumes than unweathered wire. He recommends ventilation in all cases. Dr. Warnecke noted that he expected the Fe-Al layer to be electrochemically more noble than the steel and in this case the steel would corrode. Dr. Dewitte noted that there appeared to be some zinc remaining in this coating which made it less noble than the steel.

2. Review of Research on Grain Boundary Denting:

Dr. Goodwin presented this report which is a synthesis of CRM Progress Reports 27 and 28 and the final report for the Galfan project at Lehigh University. Many figures

describing the work of the two research groups were shown. Dr. Goodwin concluded his presentation of these reports by noting the following points:

1. Surface waviness characteristics of coatings can be extracted from surface roughness measurements by setting a sufficiently high cut-off wave-length during scanning of surface roughness measurements.

2. The most important factor effecting surface waviness is the identity of the producer.

3. Factors reducing waviness include lower coating weight and lower aluminum and magnesium content. Also lower bath temperatures, higher strip-bath temperature differentials and a higher degree of skin passing reduced waviness.

4. The effect of lead content on grain boundary denting is as yet uncertain. It could minimize surface tension or cause solidification problems.

5. There is a strong correlation between eutectic grain size and incidence of denting for non-skin passed material.

6. Understanding nucleation and growth of the coating appears to be a key to improved processing.

Mr. Dubois noted that this presentation was highly technical and would be difficult to understand unless one had followed the research over the past few years. It is clear that further work needs to be done to reduce the findings of these researchers to practice. Dr. Goodwin noted that future work would be discussed later and deferred discussion of this point until then.

3. Evaluating Surface Cleanliness:

Dr. Goodwin described the principles of operation of the Meseran micro-organic residue analyzer. This device determines the contamination of a surface with organics by depositing a mono-layer of a low boiling point solvent with a C-14 tracer dissolved

in it on a horizontal steel surface. A goniometer then determines the rate of evaporation of the radio-chemical. The percent of the surface that is covered with organic contaminants is directly related to the rate of evaporation of the mono-layer from the clean steel surface. This allow quick determination of the amount of organics on the surface and thus is an indication of the efficacy of the steel cleaning processes being used. The device has been tied to a computer allowing for rapid quantitative results. Dr. Goodwin noted the importance of producing clean steel surfaces for high quality coating with Galfan. There was no discussion of these points at this time, but later comments were made in this meeting as recorded below.

4. Ten-Year Outdoor Exposure Testing of Painted Galfan:

Dr. Goodwin reported on the results of an exposure at Hialeah, Florida of samples initially coated during the first Galfan trial at Ziegler's Mouzon plant during 1981. Panels were subsequently either primed with epoxy paint or left unprimed and then painted with either an acrylic or polyester topcoat. Zinc electrogalvanized panels were used as controls. Little degradation of the primed and topcoated panels is observed after a total of 9 years. Primed and polyester topcoated Galfan panels gave the best performance and were superior to the control panels. The counterpart acrylic topcoated panels showed only minor edge blisters, minor surface degradation in general and were equivalent to the control panels. The end primed panels showed much degradation in appearance. It is recommended that the two topcoats should always be applied over a primer coat.

Dr. Goodwin offered the panels to any licensee who wished to compare them with their own long-term exposure tests. The panels can be requested from the ILZRO office. Mr. Dubois asked about the details of these samples. Dr. Goodwin noted that the process details are contained in CRM Progress Report 6 under the ILZRO project ZM-285. He believed the samples were well-characterized.

5. Galfan Bath Management Task Force:

Mr. Dubois described the current status of the Task Force work and its results. The task force was conceived in 1993 to think about the management of the Galfan pot and the nature of aluminum control. They wanted to first determine how similar results were between analytical labs. There was also the need to agree upon a sampling method for the galvanizing pot. They wanted to identify aluminum to an accuracy of ±0.1% and the rare earth additives to an accuracy of ±5 ppm. A location in the pot from which samples could be taken was determined along with the form of the sample. Cuttings were then taken from the sample for analysis. The project was intended to be cost-free, relying only upon the volunteer efforts of the task force members. Many companies were initially interested but when a deadline was set, some companies were lost. Too many samples were received for a round-robin test. It was therefore decided to have each sample analyzed by three labs. Each lab had to analyze a sample five different days with five different calibrations. Eastern Alloys also supplied reference samples for analysis. Each was analyzed on five different days by five laboratories.

Mr. Dubois noted the significant scatter that resulted from the results when they were compiled both within each laboratory and between laboratories. The aluminum standard deviation was ±0.02% for lab 1, ±0.05% for labs 2, 3, and 4, and ±0.5% for lab 5. These are absolute percentages, not relative variations.

Regarding lanthanum, the standard deviation was 5 ppm for lab 2 and 3 ppm for lab 4. All other labs fell in-between these extremes. The averages in all cases were between 240 and 260 ppm. For cerium, the range was 10 ppm standard deviation for lab 2 up to 40 ppm for lab 5.

While the above refer to the analytical standards supplied by Eastern Alloys, the pot samples were somewhat more complicated to analyze because of the presence of impurities. These were provided from producers of sheet, wire and tube. Standard deviations were seen over a wide range with very few below the target of 0.1% for aluminum. However the accuracy of lanthanum and cerium was good and also iron. Lead was also found to be easy to analyze. For the pot samples the aluminum standard deviation was 0.06 for labs 1 and 2 and 0.2-0.5 for labs 4 and 5. It is desired to clarify

some reason for the differences of results between the laboratories. One of the better labs has agreed to write a questionnaire that will help us understand the scatter.

Mr. Dubois noted that ILZRO is now starting to organize a task force on conventional galvanizing. He asked about the current situation with Galfan, asking whether the group preferred to look at the identify of the dross along with its size, shape and hardness. We could also look at the amount of drosses produced, he noted. At present, Galfan drosses are mixed in with conventional galvanizing drosses. If the volume of Galfan really grows, he thought that the same price would not be commanded as for the galvanizing drosses. Dr. Dewitte asked if both top and bottom drosses were seen with sheet coating. Mr. Dubois replied that only top drosses were seen.

Dr. Goodwin then reported on a study of Galfan bath thermodynamics and identity of drosses from Cominco's report dated October 16, 1994. In a Galfan bath at 450°C the activity coefficient of aluminum is about 3.3. The strong interactions between Al and Mg, Ce, La, and Fe shift the eutectic composition to an Al level of around 5.35%. This explains the presence of primary zinc crystals in many of the Galfan compositions that have been examined. Moreover many of the Galfan baths studied by the task force had less than 5% Al and hence are of a strictly hypo-eutectic composition. Ce, La and Fe all form aluminides with a strong affinity for formation of Al_2Ce, Al_2La and $FeAl_3$, all of which have zinc in solid solution. Ce and La are found to be neutrally substitutional in their compounds. The activity of Ce in the galvanizing bath is believed to be 4.5×10^{-8} with a similar number being attainable for La. Dr. Tang of Cominco concluded that the solubility limits of Ce, La and Fe in the Galfan bath are negligible, although these elements must be tied up in the form of intermetallic compounds, primarily with Al.

Several intermetallic compounds were examined metallographically by Cominco from four samples out of the group received from the task force members. The compositions of the chemical compounds mentioned before were verified. When large particles are present they tend to be multi-phase compounds rather than single-composition intermetallics. X-ray diffraction studies of the intermetallics in one case indicated them to be dominated by Fe_4Al_{13}. It was concluded that entrapped intermetallic particles vary in quantity from sample to sample and is the main cause of variations in composition analysis of the Galfan samples produced by the task force.

PROPOSALS FOR FUTURE RESEARCH:

Dr. Goodwin then presented the document "Research Projects Proposed for GTC Sponsorship," attached to these minutes. Regarding the first proposal for future work on reducing grain boundary dents in Galfan, Mr. Dubois noted that denting continues to be a problem especially for the electrical appliance industry where high performance standards are set. He believed that the work should go on but did not know what direction was best to pursue. He believed there to be no correlation between the denting measurements made by CRM or Lehigh and the quality evaluations made by customers on final products. Lehigh is looking at reflectivity measurements to obtain their data while at CRM mechanical roughness measurements are made. In either case, the triple points, which are the biggest problem in denting, are not reliably measured. Mr. Dubois felt that a method to determine the severity (depth) and density of the triple points would be required before more meaningful work can be done. Mr. Dubois also referred to the contradiction regarding levels of lead in Galfan. CRM had reported that statistically lead increases resulted in smoother Galfan surfaces while Lehigh related cracking in the dents to the presence of lead. If we need to reduce the amount of lead in Galfan it will be costly, he noted and will cause a change in practice by the zinc producers. He referred to older CRM work which showed the detrimental effect of lead on corrosion of Galfan in humid environments. He wondered if the work should actually be done at a university or was it best done in an industrial facility. He thought that CRM was very good with statistics, however the sample size was not very well controlled in this case. He questioned whether their statistical conclusions were true, as sometimes he has seen deep grain boundary dents with low coating weights.

Dr. Goodwin asked if a first step in the new research could be a look at differences in practices between lines. This was because the biggest single variable in determining severity of grain boundary dents was found to be the identity of producers. Mr. Dubois thought that this would be difficult. He asked why the eutectic domains seen in the samples being studied were so big. They typically ranged from 1-8 mm. Dr. Goodwin related this to the difficulty of nucleation of eutectic on the zinc crystals as shown by the Lehigh work.

Mr. Dubois asked the Galfan Alloy Licensees about the possibility of reducing lead contents in the feed ingots. Mr. Pankert noted that the zinc industry is about at the limits of purity at the level of 50 ppm lead.

There were no comments regarding the development of batch dip Galfan, the corrosion of Galfan buried in soil, and the two proposed research projects on Galfan-coated tube. Regarding the project to investigate the compatibility of Galfan with automotive phosphating bath, Mr. Dubois asked if a market study should not first be done to determine the needs of the automakers relating to Galfan. We should first determine what needs to be done to make Galfan acceptable to the auto industry before pursuing any research.

Regarding the Bath Management Task Force work, it was suggested that the Cominco report as described above be mailed to the task force members for their comments and to determine the need for future work.

Regarding the need for work on a study of steel cleanliness prior to Galfan dipping, Mr. Hennechart asked about the actual usefulness of the Meseran machine as presented by Dr. Goodwin. He asked how it could be used to measure cleanliness in the snout. Dr. Goodwin replied that this would be extremely difficult because of the temperatures involved. It is desired to know the organic pollution level ahead of time so that adjustments to the cleaning section of the galvanizing line can be made prior to running into problems with the coating. At the present time, furnace variables are changed according to the coating quality observed coming from the bath and the problem is believed to be well under control. The group agreed that it would be difficult to translate the results of work with this instrument to practical recommendations for operating galvanizing lines.

Mr. Dubois added two research ideas for the group's consideration. The first was galvanizability of new types of steels for the construction industry. Dr. Goodwin had already prepared an ILZRO Research Plan on the galvanizing of high strength steels for the automotive industry, however different types of steels are used with buildings that contain high chromium and high silicon levels. The properties in the steels are 50 kg/m^2 yield strength with a 20% elongation, Mr. Dubois noted. Galvanizing as

conventionally practiced has trouble in coating these steels because of their greater reactivity. He thought that the galvanizing of these steels could open a new prospect for Galfan. Regarding sacrificial protection, he asked about the maximum distance that Galfan could protect. Dr. Goodwin recalled the 1981 work of CRM where various widths scribes were placed into panels for various types of alloy coatings. It was found that 3 mm was the maximum that could be protected by Galfan in the industrial atmosphere of Liege.

Mr. Nünninghoff noted that he had seen no problem with Galfan coating of high strength steels using the double dip process. The steel compositions here are 0.2-0.3% Si and 0.8-0.85% C. This is a high tensile wire with 6% elongation. Mr. Pankert agreed that the galvanizing of high strength steels was an important topic, and that it was also important to investigate this for general galvanizing. Dr. Goodwin thought it may be necessary to use higher heating rates, cooling rates and soak temperatures with the high strength steels to avoid degradation of properties. Mr. Dewitte commented on the research program as presented, noting that there were no projects proposed for wire. The wire producers would have a difficult time joining the new Galfan Technology Center if no work was to be done on their product. The rest of the group agreed with this assessment, noting that a balance in the program had to be reached.

LICENSEE REPORTS:

Dr. Goodwin first presented an overall view of the Galfan market, showing the tonnages produced over the last few years and the tonnages for future use predicted by the licensees. He noted that over 2 million tons of Galfan-coated products had been produced since its commercialization. The distribution between uses was also shown on a pie chart that is attached to these minutes.

Dr. Goodwin then reported on the situation at Thyssen. All of their material is produced at Finnentrop with between 15,000-18,000 tons being made in 1984. For 1995 they predict a level of 20,000-25,000 MT.

Mr. Pelini reported on the situation at Cockerill. They had decided at the beginning of 1994 to convert their line No. 7 to Galfan. Until the end of 1993 they had produced 75,000 MT whereas in 1994 they are making 120,000 MT. This is mainly devoted to coil coated building products. For 1995 they expect the same level as 1994.

Mr. Bechem reported on the status of BREGAL. They will start their first trial at the end of February 1995. They are not sure yet what kind of product they will sell, as this will depend upon the efforts of their sales people. They expect to make 10,000 tons in the first trial.

The activities of Bekaert were reported on by Dr. Dewitte. He noted that between 12,000-15,000 MT of wire would be made in 1994, including 10,000 MT of low carbon and 5,000 tons of high carbon wire. They will convert a line in 1995 that can do either galvanizing or Galfan coatings. This will have a capacity of 10,000 MT per year. Thus they have a total Galfan capacity of 25,000 MT per year. Bekaert is in a growing situation for Galfan, he noted.

Mr. Jacque reported on the work of TrefilARBED. They have expanded their capacity for 1994 and are making 12,000 MT of low carbon wire for this year. For 1995 they expect to make 15,000 MT of low carbon wire. At Cologne, an additional 3,000 MT of high carbon wire is produced.

Mr. Payne reported on the situation at British Ropes. They have no plant yet and hence no production, however there is a possibility of putting a plant into operation at the beginning of 1995.

Mr. Drake reported on work at Tinsley Wire. They will have made 1,000 tons of low carbon wire by the end of 1994. They expect this to grow a little next year. The product is mainly directed into specialist product markets which take time to develop. About one-half of these are specification products.

Mr. Hennechart reported on work at SOLLAC. They made 22,000 tons in 1994 and expect to increase this to 27,000 MT in 1995. This may be more as they are changing their configuration and will be able to make Galfan on either of two lines next year.

There is no longer any galvanizing of conventional products in Mouzon, only aluminized and Galfan are done there. Hardly any of their product is coil coated, he noted.

Mr. Naylor reported that FFM had no production in 1994 and did not expect any in 1995. They were monitoring the market closely to determine when the best time to enter it would be.

Mr. Kavanagh reported that British Steel was seriously considering a trial up to 3,000 MT. The logistics of this had not yet been decided, however there was certainly commitment on the part of their company to run a trial.

Mr. Lankila reported that at Rautaruukki there were no immediate plans, however their involvement with BREGAL means that they have some cooperation in working with Galfan.

Mr. Dubois returned to the tonnage figures for North America and made the point that coating weight was an important issue in the selling of Galfan. He believed that the licensees should sell Galfan on the basis of coating thickness, not coating weight otherwise we are losing 10% on production costs.

PRESENTATION OF PROPOSED GALFAN TECHNOLOGY CENTER:

Dr. Goodwin presented the Galfan Technology Center plans for the future using material from the *Business Plan* previously distributed to licensees and a set of transparencies provided by Mr. Hostetler.

Mr. Dubois noted that the budget for the GTC seems very ambitious, especially when you consider the number of licenses that are predicted to be sold. He asked about the situation of the existing licensees and whether it was in their best interest to give information to the new licensees after having purchased shares to produce the information. Dr. Goodwin noted that the license fees are significantly higher these days and that even after buying a number of years worth of sponsorship in the GTC that Mr. Dubois' company would still not have paid in as much as a new licensee.

Mr. Dubois was also concerned about the many directions reflected in the Research Plan. He thought that a lot of it was not of interest to them.

Dr. Dewitte noted that ILZRO should be commended for the amount of money in the GTC budget that is dedicated to research. He believed that $3,000 for participation by Bekaert was not that much money, however it should be dedicated to their interests, i.e. wire research, otherwise it would be impossible for them to fund this work. Dr. Dewitte felt there were many issues on which the licensees could work together but hoped the plan could be made more specific. Dr. Goodwin stated that the research committee overseeing the technical work of the GTC could be set up to guarantee a place for each industry segment included in the funding of the center.

Mr. Payne noted that the *Business Plan* for the GTC is difficult to support at present. What is needed is to know that funds being contributed would be going to specific uses that would be of interest to the licensees. The group agreed that more detail needs to be put on the proposal and that it was too vague to fund at the present time.

PRESENTATION OF EUROPEAN GALFAN DEVELOPMENT ASSOCIATION PROPOSAL:

Mr. Hogan presented the proposal which is attached to these minutes regarding formation of a European Galfan Development Association. While the issues regarding the future of the GTC remain cloudy, he noted that there is a need for cooperative marketing and promotion of Galfan in Europe, which is becoming a significant growing market for Galfan. He reflected on the history of Galfan development and how it has reached where it is today. He thought that it has been a success story in many ways. He proposed an organization to take Galfan the next step forward. He thought an independent objective body would be needed to work with Euronorms and to deal with overall promotion of Galfan. The importance of global sourcing for many large corporations means that uniformity of product is a very important issue. He thought that a multi-national organization could work on this issue as well.

Mr. Hogan noted that his proposal as presented was not final but was intended to raise discussion during the meeting. His objectives were to increase the sale of Galfan-coated products to make the market aware of Galfan and its advantages and to promote and

push Galfan in terms of Euronorms. Mr. Hogan recalled the discussion that was held at the time of Galvatech '92 in Amsterdam where the motivation for having such an association was discussed. Since that time the North American Galfan Development Association has operated for several years and has been very successful in promoting Galfan and getting it into American specifications. He believed that the European group could do much the same.

Mr. Naylor expressed his concern about a statement toward the end of the proposal that only actual producers could become members. He believed that his company would never enter the Galfan market if it could not learn about the state of the market and participate in cooperative activities. Mr. Hogan defended this by noting that the present Galfan producers are the greatest beneficiaries of the association and that this is why the membership restriction has been proposed. Mr. Naylor noted that this was a conflict with Mr. Hogan's statement regarding global sourcing and the need to include as many companies as possible. Dr. Goodwin recalled the organization of the North American group which included association members in all activities except for the actual governing of the group. The non-producing members were free to participate in production and distribution of brochures, gathering of information and involvement in research projects. Mr. Beguin noted that the idea of the European Galfan Development Association is not new and recalled the proposals put forth to the industry at Galvatech '92. He committed Union Miniere to promoting this idea of an association in Europe. He believed that more emphasis had to be put on the mission of the organization and its actual job. The preferences of Union Miniere were to improve the image of Galfan by organizing good communication tools for it such as brochures and seminars, to develop proper standards which he believed were an important marketing tool and also to seek prospective customers and carry out technical promotion. He believed that much of the information required by the association could be obtained from the Galfan producers. He believed that the association needed to work on both existing Galfan producers and also prospective producers.

Mr. Beguin noted the enormity of the job of promoting Galfan in Europe and thought it might be necessary to divide Europe into north, central and southern regions in order to do the job correctly. Producers in each part of Europe could contribute only to their effort, or could support an overall general effort of which a portion could be focused on

their region. Mr. Hogan admitted that carrying out promotion for all of Europe was a huge job, however he believed that we needed to start somewhere. Mr. Pelini thought it was a dream to think that only one organization could improve the sales of Galfan. Each galvanizer has a palette of products and they have to decide a strategy for determining how they will divide up their market shares. Dr. Goodwin believed that the organization could not interfere with each company's own promotion, but rather that its best job would be to raise the image by generic promotion of the product. Mr. Payne added that the work on standards should be sure to be included in this overall effort. There is only one dedicated standard for Galfan in Europe, being the sheet standard. In wire Galfan is listed as being a product equivalent in performance to normal galvanizing. There is an effort to monitor standards activity to know what standards are being reviewed and what information they will require.

Dr. Goodwin noted that the North American Association is funded strictly to carry out activities which are contracted mainly to consultants. There is no permanent staff, with the organization being run by volunteers from the individual producers. Mr. Naylor thought that this kind of voluntary participation to run the organization was highly desirable. He believed that his money could be used better in going to two or three meetings per year and identifying projects that should be funded rather than having a central staff carry out the work. Dr. Goodwin noted that the problem with this was that brochures tend to generate many responses. There must be a central contact point for handling responses to any promotion or image-building effort.

At this point Dr. Goodwin indicated that the best way to proceed would be to have ILZRO conduct individual discussions with the licensees regarding their needs. Mr. Hogan would then be asked to revise his proposal, or a proposal would be put forward by other means, depending upon how discussions developed. Mr. Beguin made three further points before the discussion was closed: he believed that any proposal must firmly state the mission and scope of the European Galfan Development Association, who is to do it and how much it will cost. He also believed that a tonnage assessment scheme might be an interesting way of funding the organization. He believed that ILZRO could rely upon the alloy producers and steel producers to support the organization if it was properly conceived. Dr. Goodwin noted that one problem with

the tonnage assessment scheme was the great difference in tonnages between producers. This would result in one company paying 100 times more than another if it was strictly implemented.

OTHER BUSINESS:

Dr. Dewitte asked about the date and place of the next meeting. Dr. Goodwin indicated that a world meeting was scheduled to be held in West Point, New York during mid-1995. Mr. Dubois noted that it had been scheduled for June but he thought that more people would be able to attend if it was moved closer to the Galvatech meeting in September. Mr. Dubois also asked about the future research program and whether we were going to do anything in 1995. Dr. Goodwin noted that the soil burial project should continue and asked for European interest in this program. He also noted that the work of the Bath Management Task Force could continue according to the desires of members. The Cominco work, as agreed, would be sent to Task Force members for their comments and desire to do future work.

MEETING ADJOURNED:

There being no further business, Dr. Goodwin thanked the group for their participation and closed the meeting at 3:45 p.m.

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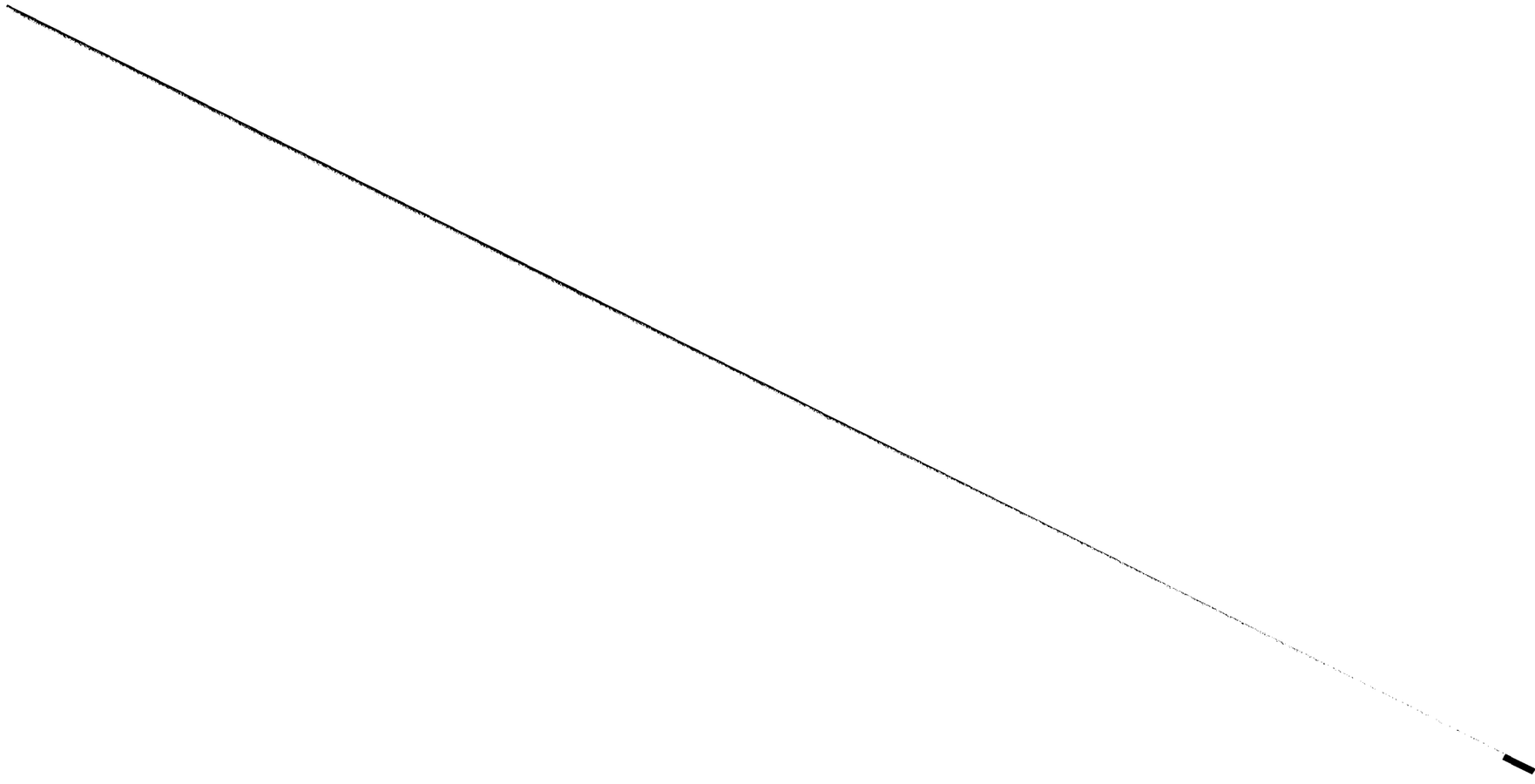

IMPROVEMENT OF GALFAN SURFACE APPEARANCE FOR COIL COATING USES

S T Bluni and A R Marder (Department of Materials Science & Engineering, Lehigh University, USA)

SUMMARY

Commercial Galfan samples have been characterized with the use of stereomicroscopy, scanning electron microscopy, quantitative X-ray spectroscopy and quantitative image analysis techniques. Surface defects were sometimes observed in the form of shrinkage cavities and solidification cracks, both of which were found to occur at grain boundaries and triple points. Coating characterization and alloy solidification studies indicate that shrinkage cavities form due to the volume change associated with the solidification process, while cracks develop from cooling stresses and impurity segregation. Results suggest that the surface appearance of Galfan coatings may be enhanced with (i) a decrease in lead content and (ii) an increase in skin-pass reduction.

INTRODUCTION

As a hot dipped zinc-based coating containing 5wt% Al and up to 0.10% mischmetal, Galfan offers excellent corrosion resistance, formability, paintability and cathodic edge protection[1]. Formability, which is superior to that of conventional galvanized steel sheet and wire[1,3,4], can be attributed to the absence or limited formation of a brittle intermetallic layer at the coating/substrate interface and the high fracture toughness of the largely eutectic coating structure[2-5]. Although there are numerous uses for Galfan and the demand for this coating continues to increase, its appearance can sometimes be marred by surface defects. As seen in Fig 1, the coating surface appearance can be quite good (Fig 1a), but is often seriously damaged by so-called 'dents' at grain boundaries and triple points (Fig 1b)[6]. The purpose of this paper is to characterize coating surface defects and to determine the effects of impurity segregation and skin pass reduction on Galfan surface appearance.

EXPERIMENTAL PROCEDURE

Twenty-six (26) commercially produced Galfan coatings were characterized with the use of light optical microscopy, scanning electron microscopy and wavelength-dispersive X-ray spectroscopy. Quantitative image analysis was used to measure the area percentage of denting by reflection using stereomicroscopy. Since this technique is sensitive to the coating grain size, and as a sample with a smaller grain size will have more potential sites for defects to occur for a given measurement area, the percentage of dented grain boundaries was determined by dividing the percentage of dented areas by the total grain boundary area for each coating.

In addition to commercial Galfan, a Zn-5% aluminium-mischmetal alloy ingot was sectioned into samples approximately 4mm x 4mm x 1mm for solidification experiments and subsequent characterization. The complete composition of the ingot is given in Table 1, which also shows that this composition is within specification as designated by ASTM B750. The samples were melted in alumina crucibles at approximately 400°C and resolidified in an argon/5.1% hydrogen atmosphere with the use of a hot stage in an Electroscan E30 Environmental SEM (ESEM). Cooling rates varied from 4.3 to 47.4°C/min. These solidification experiments were conducted in order to compare the resulting surface characteristics of the Galfan alloy, in the absence of a reactive substrate, with those of the commercial product.

RESULTS AND DISCUSSIONS

Surface characterization of commercial Galfan

When dented Galfan (Figure 1b) is studied with the use of scanning electron microscopy, two types of defects can be observed as follows:

1. Shrinkage cavities are shown in Fig 2. Such cavities arise due to the volume contraction associated with liquid → solid transformation (4.5% and 6.3% for Zn and Al respectively). This results in a lack of liquid available for solidification in the regions last to solidify, or at the triple points and grain boundaries.

2. Cracking at grain boundaries, as shown in Fig 3. These cracks form after solidification, as suggested by the matching sides of the cracks in Fig 3, and result from cooling stresses.

Lead segregated in commercial Galfan

Although the Galfan bath typically contains little lead (Table 1), this element is found to be severely segregated to grain boundary and triple point regions. Fig 4 presents a micrograph of a polished coating surface used for EPMA analysis and a plot of the resultant lead concentration data. The line superimposed on the micrograph represents the path over which concentration data was obtained, in 1μm intervals. By comparing the coating microstructure with the plot, which is drawn to scale, it can be seen that the lead concentration at the triple point (indicated as 'A') is approximately 0.3wt%, or 60 times the maximum allowable bath concentration as designated by ASTM B750 (see Table 1). Other lead concentration spikes are noted at primary zinc dendrite/eutectic boundaries

(indicated as 'B'). Such segregation can be explained by the low solubility of lead and zinc, as shown by the phase diagram in Fig 5. Hence, during the solidification process, lead will be continuously rejected into the melt - resulting in the segregation of impurity-rich, low melting point material to grain boundaries.

It is not known how lead segregation contributes to the appearance of surface defects on Galfan coatings, but the influence of impurity segregation on solidification cracking has been well established in the welding literature[7-9]. Solidification cracking can occur in any alloy system as long as (1) impurity-rich, low melting point material exists at grain boundaries and (ii) tensile stresses arise from the solidification and/or cooling process. The result is relatively weak grain boundary material which cracks upon cooling. By this mechanism, it is thought that lead segregation may contribute to the cracking found in Galfan coatings.

Effects of skin passing on denting

Although skin passing cannot eliminate the solidification defects sometimes found on Galfan coatings, it can mask surface defects and give the appearance of a smoother surface. The coatings examined in this study were characterized by a wide range of thicknesses, grain sizes and microstructures but, overall, denting is minimized with an increase in skin pass reduction. This general relationship is shown in Fig 6.

Zn-5% Al-mischmetal alloy solidification

There are two results of interest from the Galfan alloy solidification laboratory experiments. The first is that cracking at eutectic nodule boundaries and the denting at triple points as sometimes found in commercial Galfan were successfully simulated in the ESEM. These phenomena can be seen in Figs 7 and 8 respectively. Because of these findings, it can be concluded that surface depressions may be influenced by, but are not a direct result of, substrate interactions. Therefore, the fundamental cause(s) of denting must be associated with the solidification of the alloy, regardless of whether it is applied as a steel sheet coating. The second finding is that impurity particles were often observed adjacent to nodule boundaries, as can be seen in Fig 9. These impurities were identified as lead by EDS techniques; no other impurities were detected in these regions.

Mechanism for dent/crack formation

Using the information obtained from the commercial Galfan characterization and the Zn-5% Al-mischmetal solidification study, a mechanism for Galfan solidification and denting/cracking is proposed as schematically illustrated in Fig 10. At time t1, solidification of the coating begins with the nucleation of proeutectic Zn dendrites. These dendrites serve as nucleation sites for the eutectic, which grows radially from the initial nucleation site (time t2). During the solidification process, the liquid metal is quickly consumed due to the relatively large volume changes associated with the solidification of zinc and aluminium. As a result, there is a shortage of liquid between two (or three) adjacent growing eutectic nodules and, upon impingement, the interface will be subsequently curved - creating a surface depression (time t3). In addition, because impurities such as lead are continuously rejected into the melt during the solidification process, the resulting grain boundary areas should therefore be weak in comparison to the bulk coating. When stresses are induced from shrinkage due to any further solidification and/or cooling, cracking will occur within these weakened grain boundaries (time t4).

CONCLUSIONS

1 Surface defects sometimes found on Galfan coatings often include solidification shrinkage cavities, cracks and lead segregation. Cracking in Galfan coatings may be compounded by the grain boundary segregation of lead, which can act to weaken the material in these regions to promote cracking upon the application of solidification and cooling stresses. In both the commercial Galfan product characterization and the Zn-5% Al-mischmetal solidification study, lead was found to be segregated to regions adjacent to and within eutectic nodule boundaries.

2 Skin passing was found to generally enhance the surface condition of Galfan coatings. Although it does not eliminate denting, skin passing masks many surface defects, giving the appearance of a smoother surface.

3 The cracking and denting often found in commercial Galfan were successfully reproduced by melting and solidifying small samples of Zn-5% Al-mischmetal alloy on an inert substrate. Because of this, it can be concluded that surface depressions on Galfan coatings are not the result of substrate interactions, but are controlled by the solidification of the coating as an alloy.

ACKNOWLEDGEMENTS

The financial support of the International Lead Zinc Research Organization (ILZRO) and its members is gratefully acknowledged. The authors would also like to thank Eastern Alloys Inc for supplying the Zn-5% Al-mischmetal alloy and Tom Hardt of ElectroScan for operating the ESEM.

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Table 1: ***Chemical composition (%) of the ingot used for solidification studies and composition limits as designated by ASTM B750***

	Al	Ce + La	Fe	Pb	Cd	Sn
Ingot	4.90	0.055	0.016	0.0029	<0.001	<0.001
ASTM B750	4.7 - 6.2	0.03 - 0.1	0.075 (max)	0.005 (max)	0.005 (max)	0.002 (max)

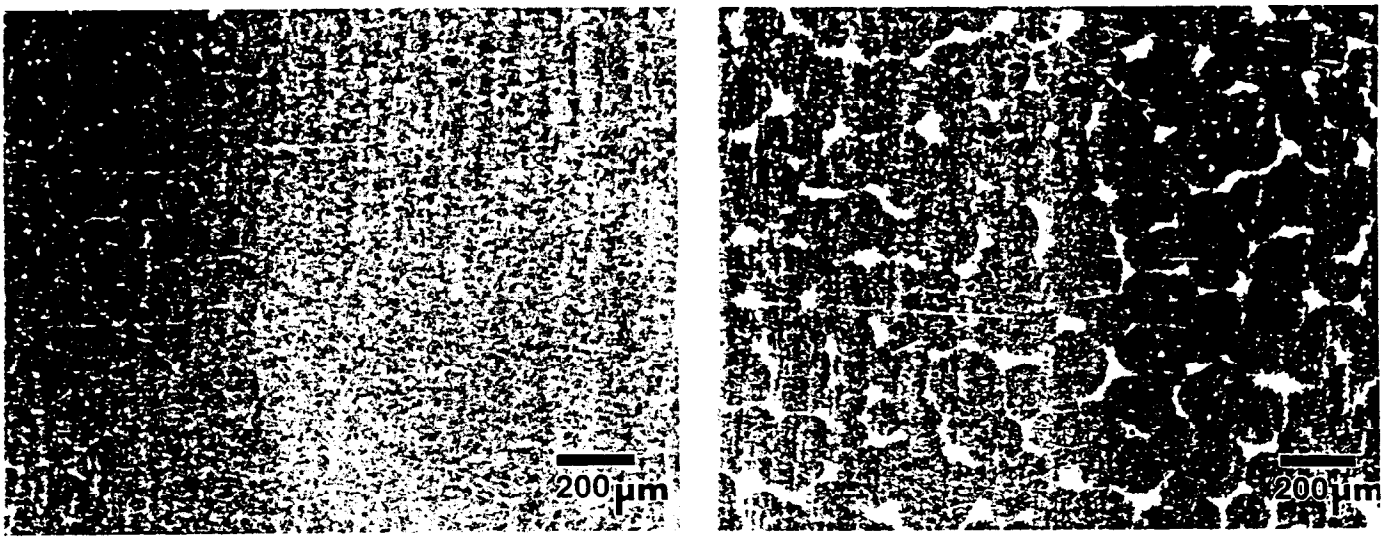


Fig 1: Examples of Galfan coatings having (a, left) a smooth surface appearance and (b, right) a dented surface appearance

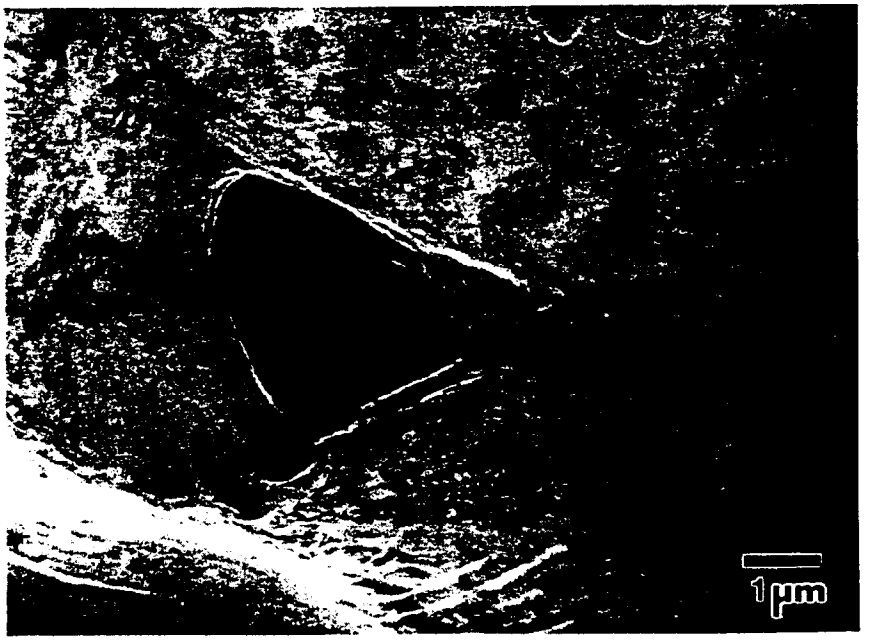


Fig 2: Example of a shrinkage cavity found at a triple point on a Galfan coating surface

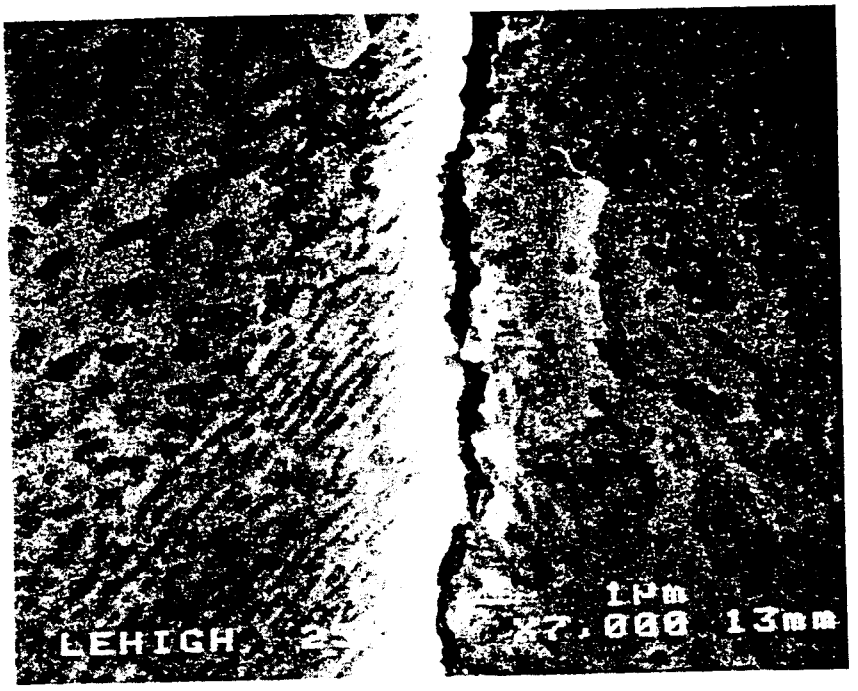


Fig 3: Cracking along a grain boundary on a Galfan coating surface

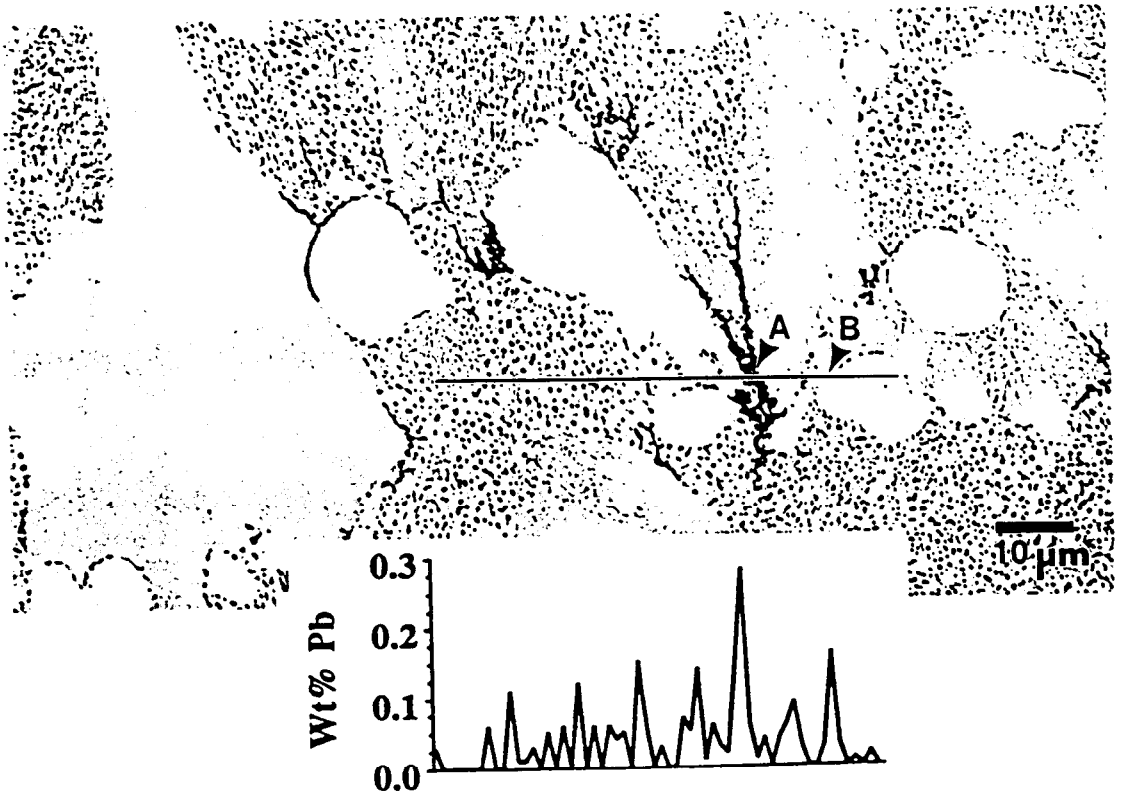


Fig 4: Polished Galfan (surface view) showing path of EPMA analysis. The lead concentration profile is taken along the line shown in the micrograph (A = triple point; B = zinc dendrite boundary)

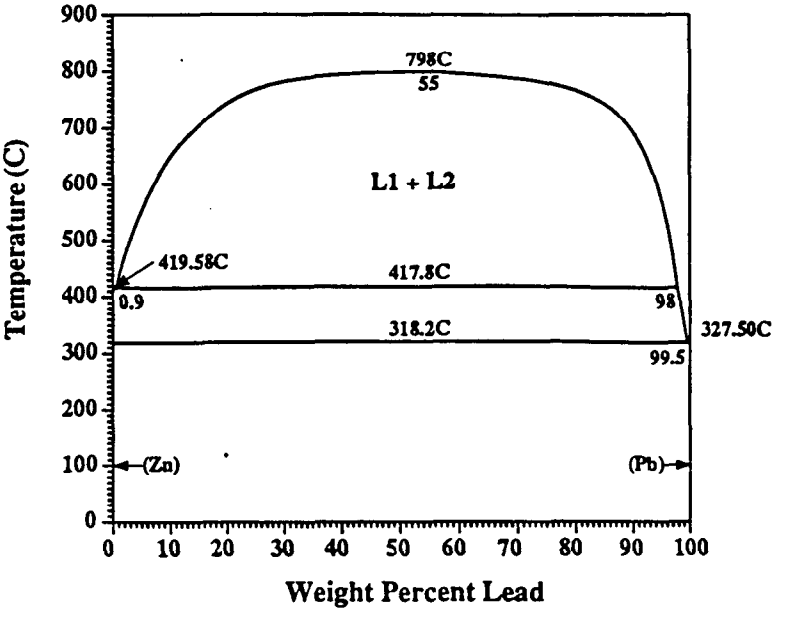


Fig 5: The zinc-lead equilibrium phase diagram

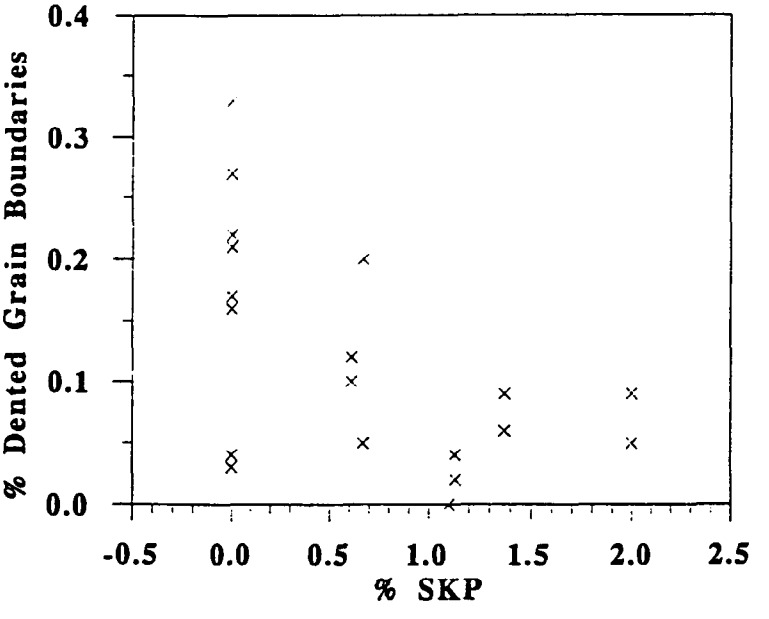


Fig 6: Denting as a function of skin-pass reduction

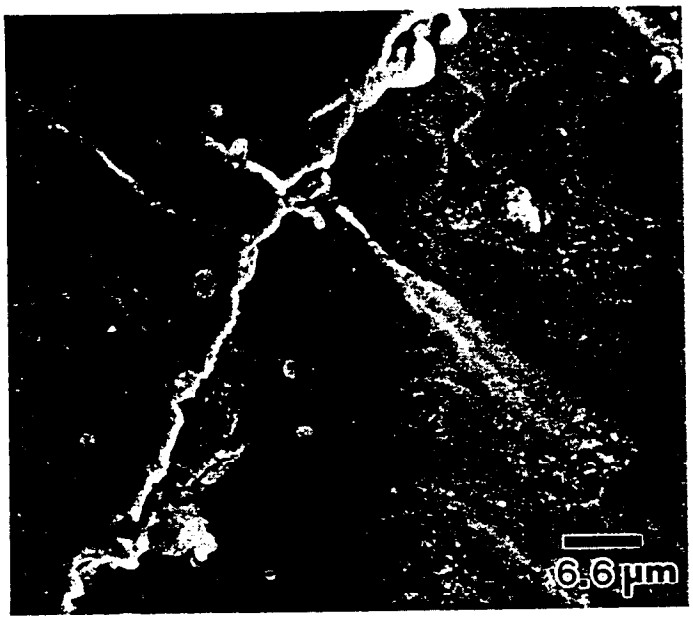


Fig 7: Cracking on the surface of the Galfan alloy

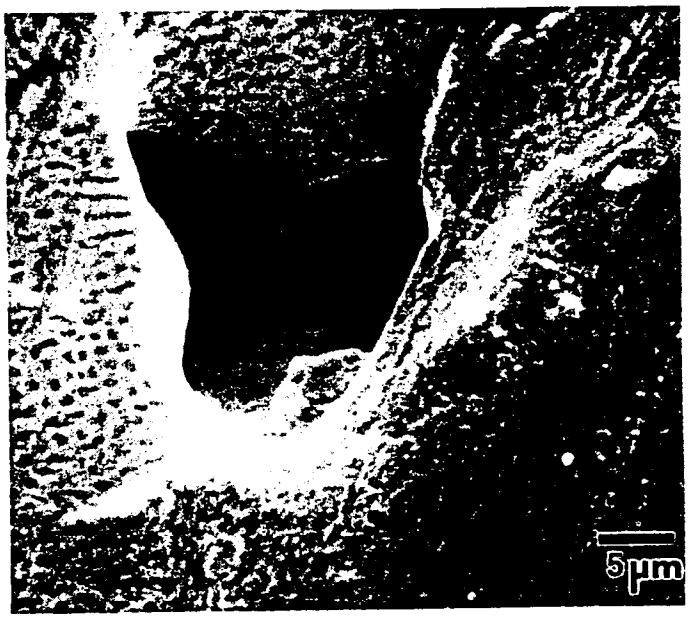


Fig 8: Shrinkage cavity formation on the surface of the Galfan alloy

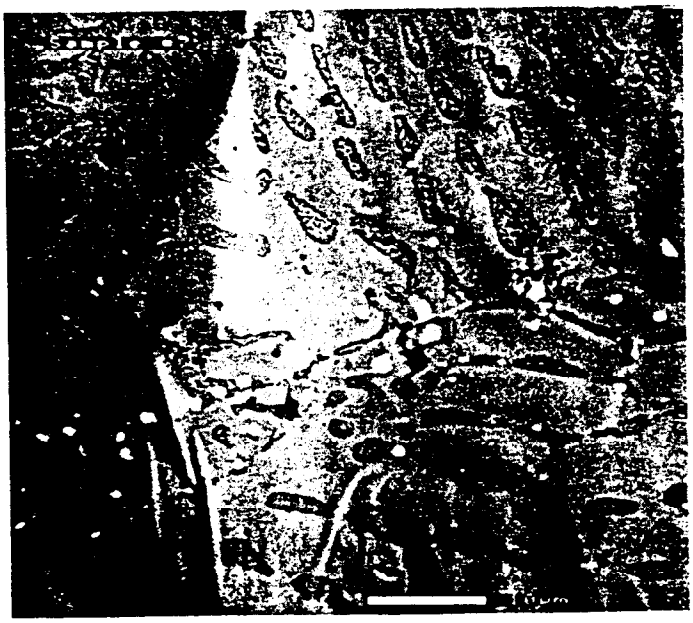


Fig 9: Lead segregation to grain boundary in the Galfan alloy

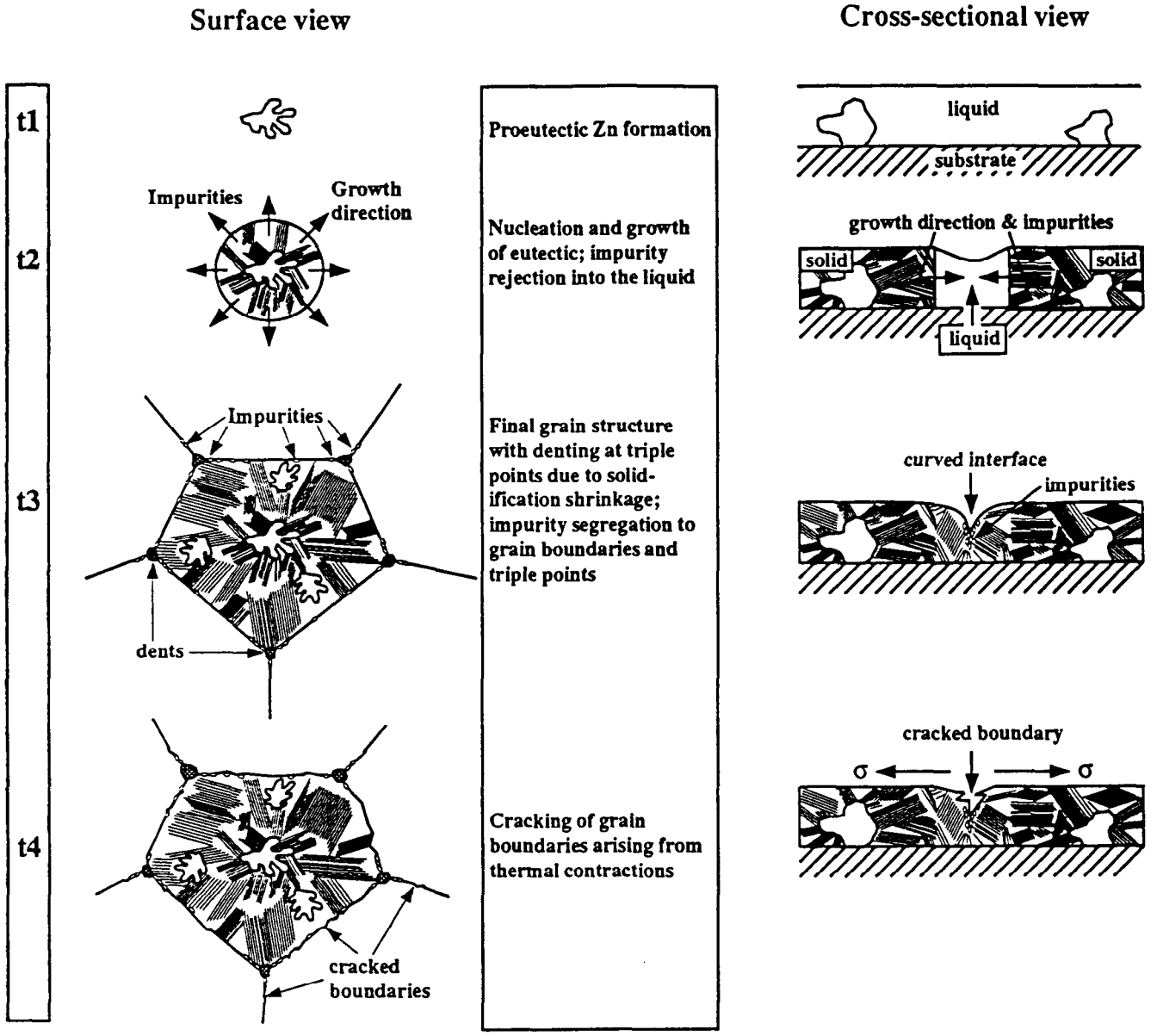


Fig 10: Mechanism for Galfan formation and denting/cracking

MESERAN™ MicroOrganicResidue™ Analyzer

Model 400 MOR™

A new 486 DOS microcomputer-based analytical instrument for the rapid, quantitative determination of the amount of MicroOrganicResidue on a surface. Useful for residues from the nanogram level upwards through four orders of magnitude, the software is preprogrammed to provide values expressed as nanograms per sq cm when calibrated against one or more of several referenced residues.

System Characteristics

>> Evaporative Rate Analysis (ERA) principle (Overleaf)

>> Calibration residues deposited volumetrically

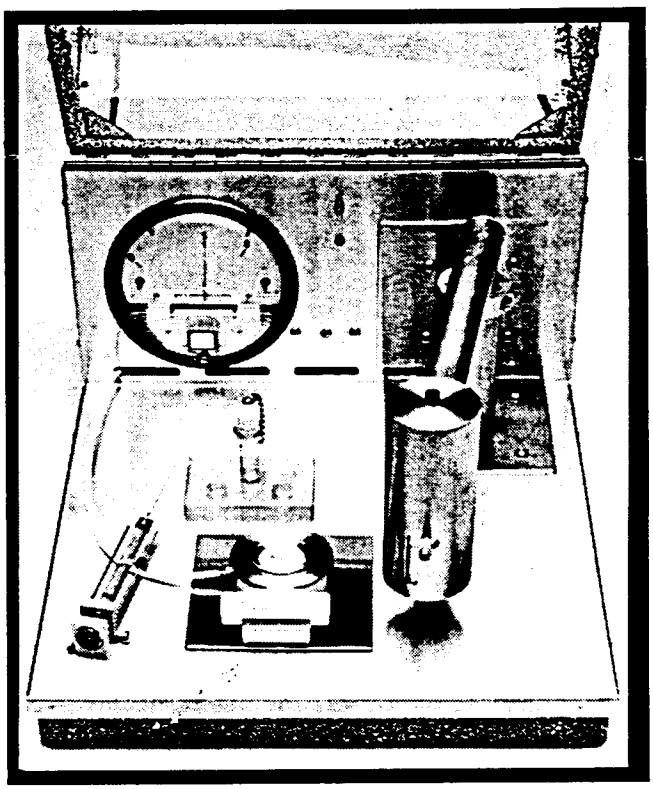
>> 486 DOS interactive microcomputer. Menu driven software supplied without charge with free upgrades

>> 2 Minute analysis expressed as a function of slope (with suitable calibration as ng / sq cm)

>> Low cost, reliable, reproducible

>> Automatic exhaust for vapor-phase chemicals

>> System may be used for rapid, quantitative measurement of solvent NVR down to 100 PPB using only 100 ul of liquid.



Instrument shown with hood open, detector assembly near 'clean' watchglass, microsyringe, MOR-SOLUTION vial with insertable closure. Not shown is the interactive microcomputer.

Size (closed): 12" W x 17" D x 8" H (not including the microcomputer)

Due to the extremely small amount of C - 14 labeled material employed in this test method, use of the system is E X E M P T from USNRC licensing regulations.

PRICE AND TERMS

1)	**Model 400 MOR System without microcomputer**	**$9,600.00**
2)	**DOS microcomputer (may be customer supplied)**	**$1,500.00**
3)	**MOR-SOLUTION Volume discounts apply**	**$150.00**

All items FOB Chattanooga
50% with purchase order; balance Net 30
System warranted for one year
Installation and Training Optional

The MESERAN MicroOrganicResidue Analyzer Model 400 MOR and MOR-SOLUTIONS are provided exclusively by:

The MESERAN Company

TEL: (615) 266 0400
FAX: (615) 698 2633

P.O. Box 3609
Chattanooga, Tennessee 37404-3609

A940222

MEASUREMENT OF MICRO ORGANIC RESIDUES ON A SURFACE

The rate of evaporation of a monolayer equivalent of a compound from a surface (at a given temperature and pressure in the absence of any interactions at the interface) is a function only of the inherent vapor pressure of the compound. Any interactions which result from the presence of organic residues in solution with such a compound cause a reduction of the vapor pressure and therefore of the rate at which the compound evaporates. The more the residue, the slower the rate of evaporation.

In a binary solution of non-polymeric compounds, the tendency of one component to occupy any position in the surface (i.e. the solution/atmosphere interface) is a function at least in part of the ratio of the size and number of the molecules of the two components. Since evaporation of a molecule can only occur if that molecule exists in the surface layer, the higher the percentage of non-volatile molecules in the surface, the slower the rate of evaporation. The interactions between molecules in a solution also affects the ability of one molecule to evaporate, i.e. to break those bonds between molecules at or immediately below the interface. This argument also applies to a degree to polymeric materials whose surface-occupying portions deny the spaces to an evaporative molecule.

In current ERA practice, a 17 microliter (ul) quantity of low boiling solvent with a high-boiling-but-volatile C-14 labeled radiochemical dissolved in it (ca. 100,000: 1 ratio) is deposited onto a horizontal or concave surface and onto any preexisting organic residue within the limits of the droplet of solvent. A G.M. detector is then positioned directly over the deposited solvent and, with metered air flowing between the surface and the detector face, the rate at which the solvent and then the radiochemical evaporate is monitored. Each analysis takes only 90 seconds. USNRC license EXEMPT labeled material is routinely employed as the radiochemical.

The observed evaporative process for residue related phenomena follows first order kinetics--the plot of log count per unit time vs time is a straight line. The slope of the observed line serves as the best measure of the evaporative process and thus is used to quantify the amount of preexisting organic residue. Expressed as a positive integer, the slope is inversely proportional to the amount of residue. Calibrations employing typical expected residues are readily carried out using 10 microliter depositions of 10 ml volumetric dilutions of those residues. The resultant relationships of slope versus amount-of-residue permits facile establishment of calibration curves for the measurement of unknowns.

For a wide variety of organic oils and greases, the sensitivity of the method permits quantitative measurement from a few nanograms (a small fraction of one molecular layer per square centimeter) upwards through ca. four orders of magnitude.

MESERAN 11931

MESERAN (tm) MICRO-ORGANIC-RESIDUE (tm) ANALYZER
Model 450 MOR (tm)

Application Notes

1. The first application of the MESERAN MICRO-ORGANIC-RESIDUE ANALYZER involves direct deposition of 18 microliters of a preselected low boiling solvent containing ca .00002 parts of a license EXEMPT radioactive C-14 labeled high-boiling-but-volatile compound onto the test surface followed by placing a thin end-window GM detector directly above the deposited solution. Then as metered air or nitrogen flows across the surface and under the detector, the rate at which the radiochemical evaporates is monitored by determining the amount of retained radioactive material in sequential time periods.

Assuming that the preselected solvent dissolves substantially all of the preexisting residue, the observed rate of evaporation bears a first order relationship to the number of molecules so dissolved following the initial evaporative disappearance of the low boiling solvent (shown by increasing count as the solvent evaporates) . Thus a post peak plot of log count vs time is essentially a straight line where the slope of that curve is the preferred measure of the amount of preexisting residue. When converted to a positive integer, this slope correlates inversely with the amount of preexisting residue. The ultimate lower limit of the method approaches one nanogram of residue--the upper effective limit is ca. 30,000 nanograms. In terms of molecular layers per square centimeter, these values represent at the lower limit ca. one twentieth of one monolayer up to ca. 200 such layers.

2. The second and preferred test application involves the use of a reference surface such as a precleaned watchglass onto which an aliquot amount of an extracting solvent is deposited (and evaporated thereby depositing the micro organic residues (NVR) which were present in that solvent) in such a way that 18 microliters of subsequently deposited radio-active testing solution covers and solvates substantially all of the residual deposit.

This method has the advantage of eliminating all surface effects which may affect the direct determination by interfering in the laminar flow of air or nitrogen during the test as well as the necessity for mechanically maintaining the testing surface in an level condition.

This second application also provides a method for precisely and accurately determining non-volatile micro organic residue (NVR) in liquids to a level of 0.1 PPM based on only 100 ul of liquid.

E R A Systems, Inc
The MESERAN Company
50 North Crest Road
P O Box 3609
Chattanooga, TN 37404-0609

TEL: (615) 266 0400
FAX: (615) 698 2633

MEMORANDUM NO. MOR - A

QUANTITATIVE MEASUREMENT OF MICROORGANIC RESIDUE (MOR)
(Unpublished work)

Data based on dipentyl phthalate (DPP) deposited onto clean watchglasses

DPP is an analog of dioctyl phthalate (DOP)

Test Solution employed was tetrabromoethane-C14 in cyclopentane (1:66,000)

The automatic MESERAN Surface Analyzer Model 1200 was employed

Duplicate tests as shown

SLOPE	MOR
79, 79	Blank
81, 77	2.3 ngr
72, 70	23 ngr
52, 52	230 ngr
9, 6	2300 ngr
2	23,000 ngr

Data obtained by R. P. Donovan, E. A. Hill, and K. D. Carter, Jr.
Data Analyzed By P. A. Lawless
Work performed at RESEARCH TRIANGLE INSTITUTE, 1991
Results reported 1992
Program funded by IBM ROCHESTER

ZM-427 "Ten-Year Inspection of Painted Galfan® Panels"

Progress Report 1 (Final)
Issued: August 31, 1994

The subject report describes the condition of steel panels coated with Galfan during the first Galfan trial during 1981 at Ziegler's Mouzon plant. Panels were subsequently either primed with epoxy paint or left unprimed, and then painted with either an acrylic or polyester topcoat. Samples were exposed during 1983 in the high rain, high ultraviolet climate of Hialeah, Florida. Zinc electrogalvanized panels were used as controls.

Little degradation of the primed and topcoated panels is observed after a total of nine years exposure. Primed and polyester topcoated Galfan panels gave the best performance and were superior to the control panels. The counterpart acrylic topcoated panels only showed minor edge blisters, minor surface degradation in general and were equivalent to the control samples.

The unprimed panels showed much degradation in appearance. It is recommended that the two topcoats studied always be applied over a primer coat.

The samples are now archived at ILZRO and will be available for comparison with panels emerging from similar programs being conducted by licensees.

We are grateful to E.I. DuPont de Nemours Co. for their underwriting of the initial portion of this program, including the painting of the panels with their products.

Distribution to:

ZPTC (Unitholders Only)
Galfan Sheet Licensees

CORROSION TEST

- INDOOR LABORATORY TESTS
  - test conditions
  - test results : comparison between Zinc and Bezinal®
- OUTDOOR EXPOSURE TESTS
  - difference in life expectation between Zinc and Bezinal®
  - demonstration of the very efficient cathodic protection as observed on welded mesh
- HOW TO EXPLAIN THAT 5 % ALUMINIUM / 95 % ZINC CAN RESULT IN 2 TIMES BETTER CORROSION RESISTANCE THAN 100 % ZINC

Salt Spray Test Comparison.

Bezinal - Double Galvanised Fishing Rope Wire.

Double Galvanised Wire (Redrawn)

S.S. Hours	Initial C.	Residual C.	Consumed	Mean
24	245	199	47	42
	269	235	34	
	227	182	45	
96	269	134	135	134
	194	77	117	
	245	97	148	
120	259	113	146	138
	292	148	144	
	198	75	123	
144	268	85	183	172
	268	93	175	
	256	97	159	
168	218	32	185	185
	217	36	180	
	230	41	190	
192	196	16	180	182
	191	10	181	
	223	36	186	

Bezinal Wire (Redrawn)

S.S. Hours	Initial C.	Residual C.	Consumed	Mean
24	148	141	7	9
	150	137	13	
	150	144	6	
96	149	100	48	42
	148	107	41	
	150	113	38	
120	151	95	56	49
	147	99	49	
	150	107	43	
192	151	74	77	79
	149	67	82	
	152	74	78	
264	148	35	113	111
	149	32	117	
	146	42	104	
288	149	25	125	122
	149	25	124	
	150	33	117	
312	148	25	124	119
	151	39	112	
	149	28	121	
336	150	11	140	129
	150	25	125	
	145	25	121	
432	146	12	134	133
	148	18	131	
	149	14	135	
456	147	5	142	139
	148	11	138	
	146	9	137	
504	148	7	141	140
	148	9	139	
	150	9	141	
768	154	7	147	144
	148	7	141	
	151	7	144	

HOW TO EXPLAIN THAT 5 % ALUMINIUM / 95 % ZINC CAN RESULT IN 2 TIMES BETTER CORROSION RESISTANCE THAN 100 % ZINC

---

1. Electrochemical approach of the corrosion reaction.

2. Parabolic trend of coating loss during salt spray test.

3. Aluminium enrichment of a corroded Bezinal® surface.

4. Residual coating at red rust.

5. Corrosion protection even at the welds : related to the binary phase diagrams Fe/Zn versus Fe/Al

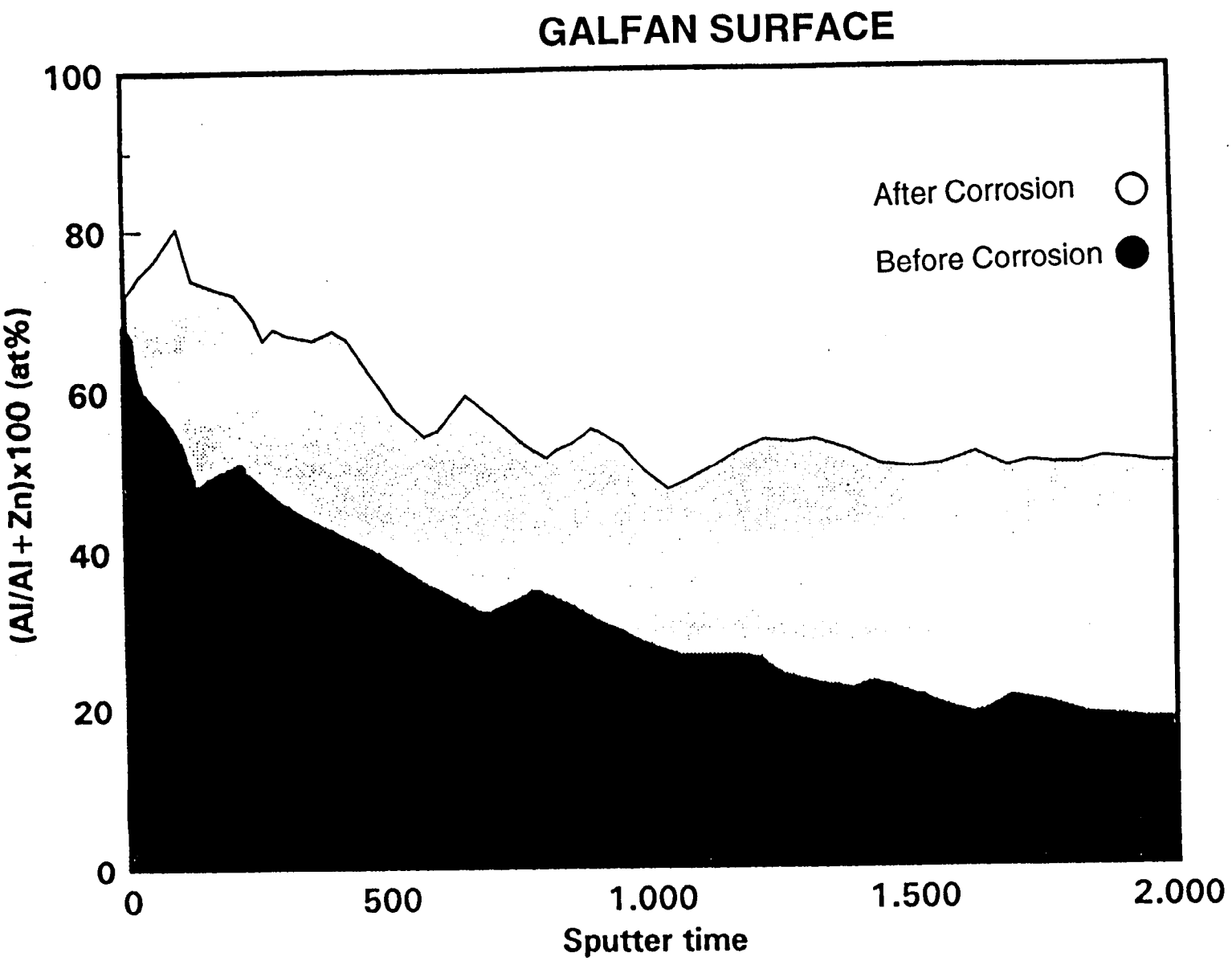
Conclusions of a considerable expertise in corrosion comparison between ZINC and BEZINAL® coated wire products

Versus Zinc, Bezinal® guarantees two times better corrosion resistance and therefore a two times longer lifetime expectation.

- Aluminium helps to passivate the corrosion activity, right from the beginning, but more and more pronounced during the total life cycle of the coated steel wire products.

Contrary to Zinc, with Bezinal® red rust is delayed until the ultimate attack of the alloy layer. The galvanic protection at cut ends, uncoated or damaged spots and welded mesh is extremely efficient with Bezinal®.

The latter may be due to the protection efficiency of the Fe/Al/Zn alloy layer and also to the well-known better conductivity of Aluminium.


GALFAN SURFACE
100
80
60
40
20
0
(Al/Al+Zn)x100 (at%)
0
500
1.000
1.500
2.000
Sputter time
After Corrosion
Before Corrosion

GALFAN TECHNOLOGY CENTER

An ILZRO Technology Transfer Program*

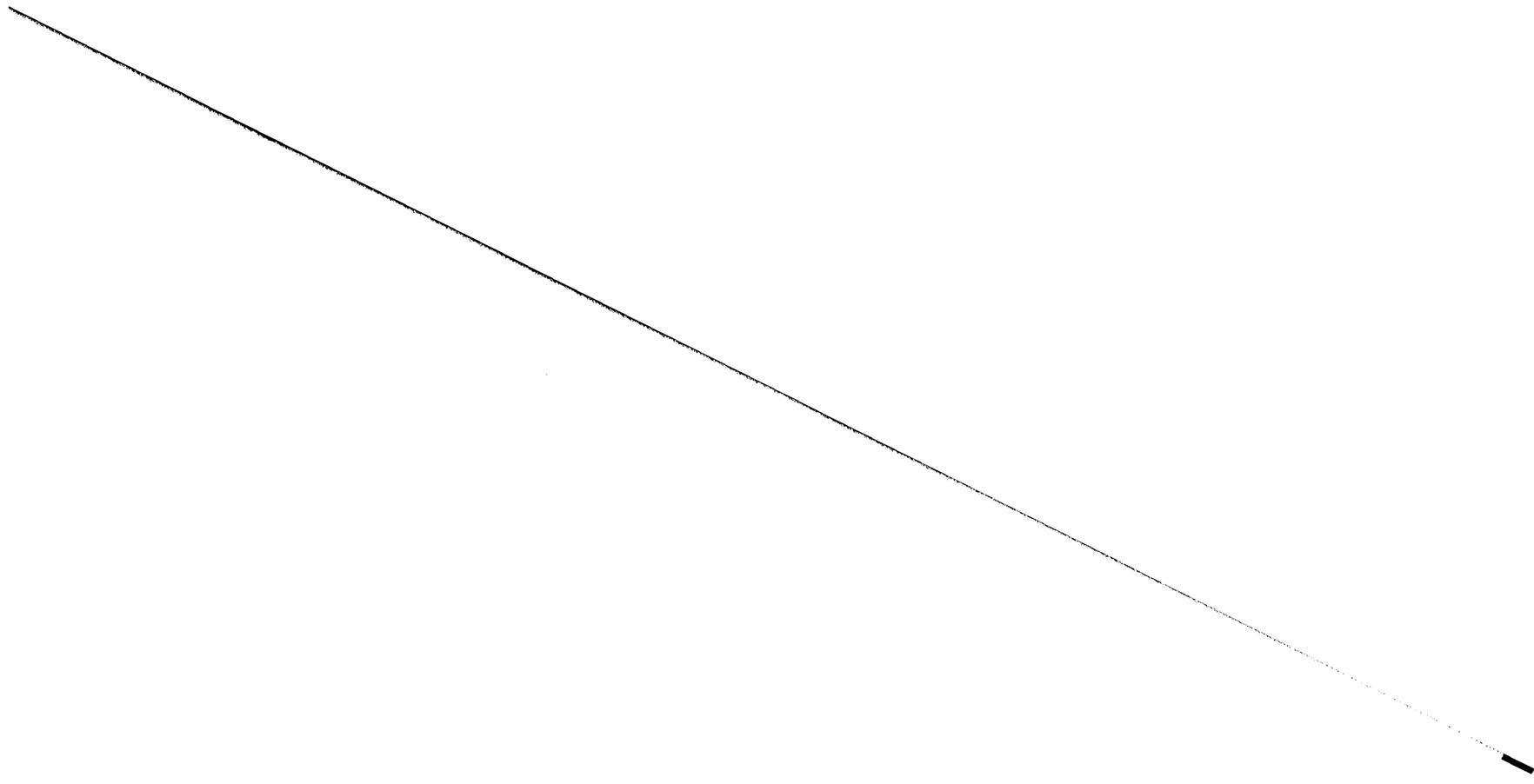
*INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION

UNITHOLDER EDITION

GTC BUSINESS PLAN

1995 thru 1997

December 1994



GTC
BUSINESS PLAN

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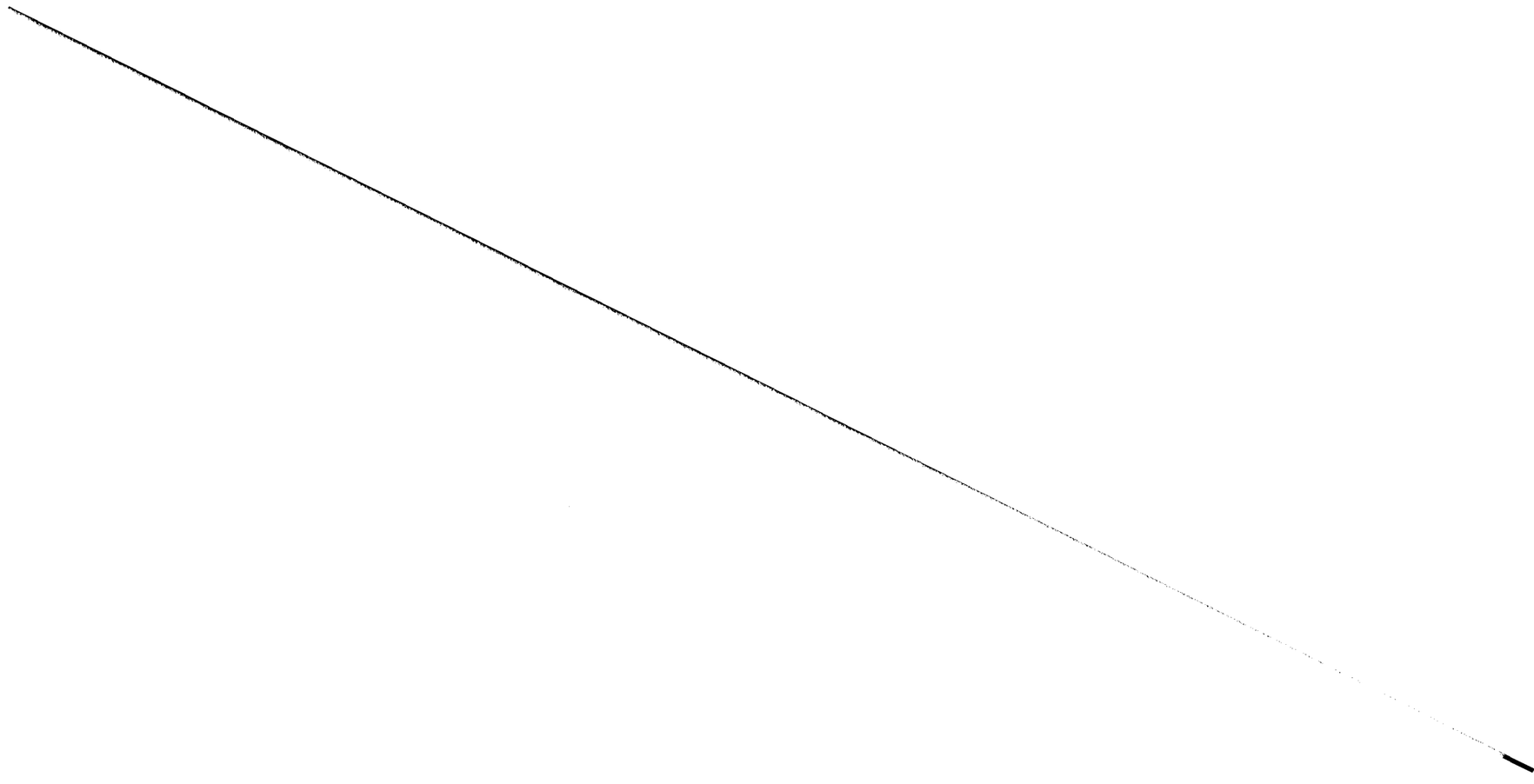


MISSION STATEMENT

To increase applications of galvanizing available to the zinc and steel industries by improving the performance of galvanized steel with the use of Galfan alloy.

A SUMMARY

Galfan Technology Center (GTC) is the proposed successor to Galfan Technical Resource Center (GTRC), created in 1987 by ILZRO to provide administrative and technical support to the efforts by regional Zinc Marketing Development Associations to promote Galfan. Whereas GTRC was largely *reactive* in the use of its resources, GTC will to be more *proactive* to better position Galfan in the current and future global situation.

Is the change necessary? We think so because ...

Galfan is maturing. The novelty is gone. Galfan is no longer new. Licensees have galvanized more than 2 million metric tons of steel sheet, wire and tube with Galfan in Europe, Japan and North America in the twelve years since the first commercial production. Accepted standards and specifications that recognize Galfan's unique characteristics are now in common use.

Patents are expiring. Some will expire as early as 1995. The ILZRO-owned Galfan patents have been the primary asset of the license. Prior licenses terminate upon expiration of the applicable patents .

More funding is needed. Existing markets will be expanded and new ones created only if we continually improve Galfan technology through more sponsored research and development.

These and other reasons require that ILZRO change to the GTC plan.

This revised edition of the GTC Business Plan reflects the discussions and feedback from the regional licensee meetings held in Kobe, Dearborn and Luxembourg in 1994. ILZRO shall review the plan at the end of each calendar quarter and revise it as required.

OVERALL OBJECTIVE

GTC's overall objective is to create and transfer Galfan technology that will meaningfully support the marketing efforts of licensees' and Galfan development associations. Immediate GTC activities might include:

- more extensive Galfan literature search and review;
- support regional Galfan development associations;
- customized computerized Galfan Life Cycle Cost comparison; and
- enhance and improve technical applicability of research data;

INCOME

GTC has two major sources of income closely related to its two arenas of activity.

1. Unitshare sales are meant to recover GTC's out-of-pocket costs for providing services to the unitholders and Galfan development associations. GTC hopes that all active licensees will chose to buy a GTC unitshare but it must anticipate that some will not.

2. The other source of income is new license fees from which the cost-of-sale, costs to establish the licensee and GTC's administrative costs must be deducted. The remainder of new license fees is committed to Galfan market development and research and development. See Table A.1.

BENEFITS OF MEMBERSHIP

Membership in GTC does not constitute ownership of GTC but a unitshare grants the unitholder access and rights to use research and technology published by GTC in the unitshare year.

A major benefit of GTC membership is the unitholder's vote in determining how the GTC-sponsored research and development budget will be spent. Additionally, the unitholder has immediate access to current progress reports for GTC-sponsored research and development projects.

GTC plans to invest more than US$1,000,000 in Galfan research and development during the three years 1995 thru 1997. GTC and its unitholders shall be the exclusive owner of research funded solely from the GTC budget.

Progress reports of such research and development shall be considered proprietary and confidential to GTC and its unitholders. The Executive Summary of each project shall be distributed to GTC unitholders and to other Galfan licensees. Galfan research not solely sponsored by GTC may be shared with other project sponsors.

The nominal cost for a GTC unitshare is tremendous leverage for the unitholder, e.g., a unitshare costing $4,000 is projected to buy a unitholder more than US$250,000 worth of Galfan research in 1995, a ratio of 60:1.

The GTC research and development budget shall be managed by the GTC Research Steering Committee consisting of at least four GTC members and the chairperson, ILZRO's Vice President of Materials Sciences, Dr. Frank E. Goodwin. Reasonable effort shall be made to keep the ratio of benefits-to-unitshare sales comensurate with the ratio of income-to-license category.

Goals for 1995

- Develop technical support to expand the base and penetration of Galfan products in all appropriate markets,
- Develop more standards and specifications for Galfan products.
- Establish GTC's credibility and value to licensees.
- Train the Galfan Technology Sales Representatives.
- Organize the Technology Transfer Program.

Objectives for 1995

• Assist the establishment of a Galfan Licensee Association in Europe and Japan. Provide meaningful technical support for North American Galfan Development Association.

• Produce a multi-language four-color Galfan portfolio.

• Organize the world-wide GTC and Galfan licensee meetings to be held June 19-21 at West Point, NY.

• Create and publish a handout piece of literature *Facts About Galfan* to be printed in English, French, German and Spanish.

• Create and publish *Galfan Applications in the Automotive Industry,* a portfolio of technical reports emphasizing Galfan's features for Galfan sheet, tube and wire products used in the automotive industry.

• Develop a reliable single-dip Galfan process for small parts, fasteners and accessories needed by customers buying Galfan tube and wire products.

TABLE A.1

SUMMARY OF PROJECTED BUDGETED INCOME AND EXPENSES

INCOME	1995	1996	1997
CARRY-OVER FROM PREVIOUS YEAR	102,000	52,000	46,300
UNIT SHARES	114,500	158,500	224,500
LICENSE FEES	625,000	825,000	780,000
TOTAL INCOME	**841,500**	**1,035,500**	**1,050,800**
EXPENSES PROPORTIONAL TO LICENSE INCOME			
RESEARCH and DEVELOPMENT	257,125	399,975	402,750
ILZRO ROYALTY	62,500	82,500	78,000
SALES COMMISSIONS	62,500	82,500	78,000
TECHNOLOGY TRANSFER CONTRACTORS	78,125	73,400	45,150
LEGAL FUND	12,500	16,500	15,600
ADVERTISING	43,750	20,625	19,500
TOTAL VARIABLE EXPENSES	**516,500**	**675,500**	**639,000**
EXPENSES INDEPENDENT OF LICENSE INCOME			
GTC OPERATING BUDGET	**273,000**	**313,700**	**372,390**
TOTAL EXPENSES	**789,500**	**989,200**	**1,011,390**
SURPLUS	**52,000**	**46,300**	**39,410**

B PROGRAM

GTC is a program to expand markets and market shares for Galfan by creating knowledge through research and development, synthesizing that knowledge into technology and transferring that technology to licensees.

The current Galfan technology is based on knowledge gathered from past research, laboratory experiments, field trials, production experience and other galvanizing experiences. It is available to all Galfan licensees through meetings, seminars, published papers and documents or Galfan Technology Transfer Contractors.

New Galfan technology will come from the same sources, especially GTC-sponsored research. GTC unitholders help determine the specific research to be sponsored through a prioritizing voting process to a research steering committee.

GTC PROGRAM OWNERSHIP

GTC is a subsidiary department of International Lead Zinc Research Organization (ILZRO), a not-for-profit organization owned by the leading zinc and lead producers throughout the world. This plan will gradually phase GTC into a self-sustaining for-profit organization but retaining a strong affiliation with ILZRO.

The cost to operate GTC shall be funded (about equally) from GTC unitshare sales and new licensee initiation fee income. Unitshare sales are sold annually to qualified Galfan licensees. Initiation fees are credited from new license income.

PROGRAM PRODUCTS

GTC's products include published results and applications of Galfan research, Galfan technology and know-how. These products are distributed in the form of printed documents and other media to those qualified to receive them.

GTC synthesizes knowledge from completed ILZRO-sponsored research, its own experience, third party consultants, licensees and other galvanizing technology resources. See page 11.

SPONSORED RESEARCH PROGRAM

Galfan's quality, productivity and profitability will remain competitive in quality and cost only if process technology and know-how are constantly improved. Past research sponsored by ILZRO has provided much helpful scientific knowledge about Galfan but much more is needed.

Reliable scientific research costs money. GTC's plan projects a three-year research and development budget of more than US$ 1,000,000 from new license sales to pay for the needed research.

GTC's research and development budget shall be divided into two parts, (1) basic research and (2) product and process development. Basic research shall be given about 60% of the budget for scientific work by qualified research contractors. Product and process development shall be given about 40% for product or process improvement by licensees' researchers or qualified suppliers.

The primary research contractors will include some who have done satisfactory Galfan work for ILZRO in the past. GTC shall also invite other published investigators to submit proposals to expand or complete their Galfan or Zn-5%Al projects.

Notable process development has been done by some licensees and suppliers using their own resources. GTC shall consider providing financial assistance from its budget for such efforts in the future, and may in some cases, be able to assist the developer in obtaining grants from other sources.

All GTC-sponsored research and development project shall be from recommendations made by the GTC Research Steering Committee. Committee members shall be selected by GTC unitholders at the bi-annual world-wide licensee meetings. It shall be chaired by ILZRO's Vice President of Materials Sciences. Each unitholder shall be given an opportunity to vote a priority for each recommended project. The committee chairman shall lead the committee's discussions in selecting the projects and making all appropriations from the money available.

GTC unitholders should nominate research and development projects so that sponsored projects reflect actual needs to expand markets or improve product quality or profit. Projects already nominated include:

1. Develop a smoother dent-free Galfan surface.
2. Evaluate Galfan corrosion when buried in soil or concrete.
3. Galfan bath management.
4. Develop electroless flux for single-dip Galfan methods.

All GTC-sponsored research and development shall be managed by ILZRO as regular projects with GTC as the sole shareholder.

The Executive Summary of all GTC-sponsored research projects shall be available to Galfan licensees but distribution of progress reports of GTC-sponsored research projects shall be limited to GTC unitholders.

MARKET SUPPORT PROGRAM

GTC's primary objective is to help licensees expand existing uses for Galfan products and to find new applications. It can do this by providing

(a)technology that will improve the Galfan product and (b)technical information to support his sales and marketing efforts.

STANDARDS PROGRAM

Standards and Specifications are important to market development because they give specifying engineers, architects and buyers authoritative third party specifications to reference. Standards also give the user more confidence that his requirements will be met.

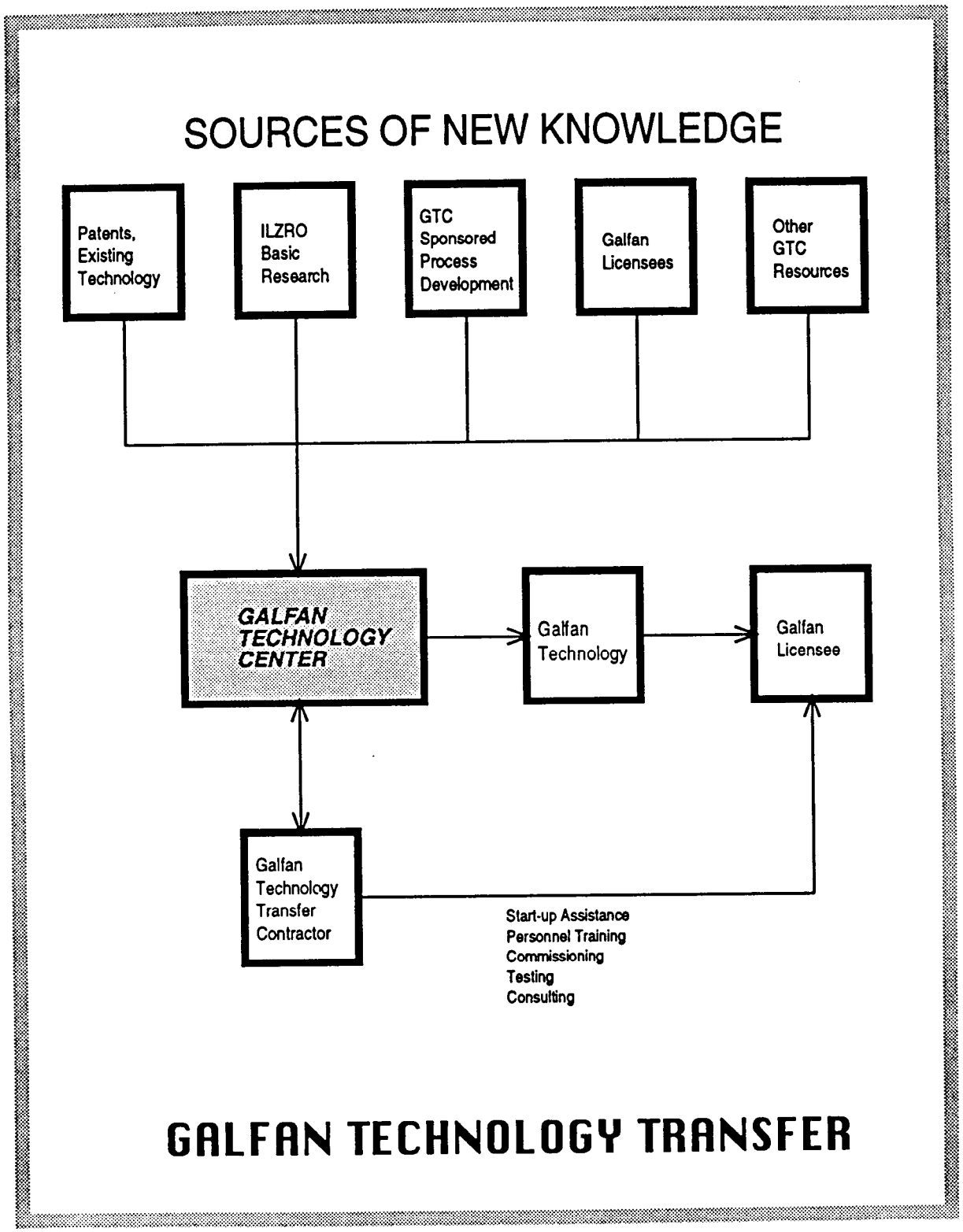
The regional markets in which Galfan is sold use ASTM, Euronorm or JIS standards and specifications. GTC shall support regional Galfan Development Associations to monitor these and to participate where appropriate for promoting specifications for Galfan applications and assuring that all Galfan specifications are appropriate and technically correct.

LEGAL FUND

GTC will need legal services to defend the Galfan patents, file for new patents, and to prepare revised license agreements, independent contractor agreements, etc. Money based on a small percentage of the license income shall be set aside in a legal fund to pay for such services.

ADVERTISING FUND

There are exhibitions, media advertising, literature, etc. that can greatly assist in the promotion of Galfan. A small percentage of the license income shall be set aside in an advertising fund to allow GTC to take advantage of such opportunities.


SOURCES OF NEW KNOWLEDGE
Patents, Existing Technology
ILZRO Basic Research
GTC Sponsored Process Development
Galfan Licensees
Other GTC Resources
GALFAN TECHNOLOGY CENTER
Galfan Technology
Galfan Licensee
Galfan Technology Transfer Contractor
Start-up Assistance
Personnel Training
Commissioning
Testing
Consulting
GALFAN TECHNOLOGY TRANSFER

C MARKET

The galvanizing industry will continue to grow at a healthy rate as steel continues to be the material of choice for many applications because it is strong, relatively low-cost, versatile, reasonably friendly to the environment and easily recycled. Large users of steel including automotive, construction, highway and transportation, marine, mining and appliances recognize the benefits of galvanized steel and have consistently expanded their use of it. The industry predicts this trend will continue.

Galfan will both contribute to and benefit from this growth. Its contribution will be improved performance for the user and profitability for the galvanizer. It benefits from the market's increased recognition and acceptance of galvanized steel products. Forecasts of Galfan's growth from existing Galfan licensees' reports are shown in Figure 4.1.

Major improvements in continuous strip galvanizing technology have been made in the last fifteen years. This is best seen in the dozen or more recently commissioned high-output hot-dip strip galvanizing lines. These newer lines produce automotive-quality hot-dipped galvanized strip at rates of 200,000 to 450,000 tons each per year. The best of the older lines, the second tier, typically produce 150,000 to 300,000 tons each per year. Most have been upgraded and improved significantly to offer the appliance and construction industries the now-achievable higher-quality product. The third level lines will continue to supply the general fabrication, HVAC and construction industries with common grades of galvanized sheet.

Galfan is improved galvanizing so it follows that whatever regular galvanizing does, Galfan can do better. There are exceptions. Galfan will not, for instance, be used extensively for exposed automotive-quality products until three problems are resolved. First, Galfan's surface must be smoother with less waviness so that its DOI will be acceptable. Second, its high aluminum content may react unfavorably with commonly used automotive phosphate pre-treatments. Third, welding specifications differ from other zinc coatings.

Although Galfan offers some very attractive features, until our research finds a solution to these problems, Galfan is better suited to the second and third tier strip lines that serve the appliance, architectural and general markets.

Ten years' experience has shown Galfan to be outstanding as a galvanized coating for wire, both for low-carbon and high-carbon grades. Much of the world's wire galvanizing is now done on old lines that are limited and very inefficient. Many new wire galvanizing lines will be built in the next ten years and many more existing lines will be upgraded. Galfan is an attractive opportunity for many of them to offer a second or premium coating.

Galfan's quick and intense penetration into the small-diameter automotive tubing market in North America has developed proprietary process technologies that can be used for galvanizing larger diameter tube with Galfan as well.

A demand for Galfan-galvanized small parts is growing out of the need for accessories compatible with Galfan sheet, wire and tube fabrications and ACSR cables. A thermally stable flux is now available that allows small parts to be pre-heated thus overcoming the thermal interfacial problems common to galvanizing low area-to-mass ratio small parts with Zn-Al alloys. Galfan is expected to become a very popular coating for fasteners and small parts because it offers greater corrosion resistance with thinner coatings than regular galvanizing or sheradizing.

Although we can be optimistic that Galfan will eventually be used for general batch-dip galvanizing, more research is needed to develop reliable and practical technology before GTC can promote it commercially.

The market for Galfan will further expand from showing galvanizers the potential profit available from offering Galfan as a premium galvanized product. GTC will gain their confidence in Galfan by building value into the Galfan technology through research and development and by supplying meaningful technology and technical services to licensees.

MARKET REGIONS

Seven distinct geographic areas are identifiable as independent Galfan market regions. They are:

- Asia not including China and Japan
- Australia
- Peoples Republic of China
- Europe
- Japan
- North America
- South America

Each of the regions should ideally have one Galfan Technology Sales Representative whose primary responsibility will be to identify the potential Galfan Licensees in each category, to develop a plan that will acquaint them with Galfan's potential for them and to promote the sale of a Galfan license.

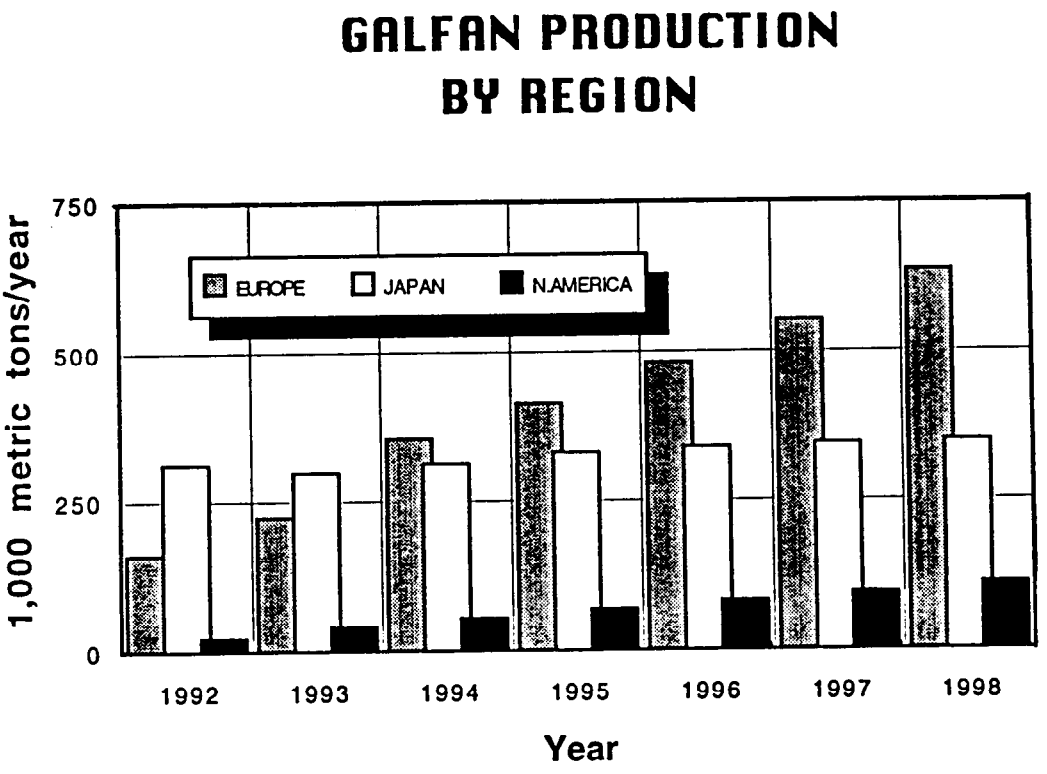


Figure 4.1 Galfan Production by Region as reported by the Galfan licensees. 1992 and 1993 are historic. 1994 thru 1998 are forecasts.

D ORGANIZATION

COMPANY HISTORY

GTC is the successor to Galfan Technical Resource Center (GTRC) which was established in 1987 as an ILZRO Project funded by regional zinc market development associations. New funding from sales of unit shares began in 1991. Unitholders included zinc companies, steel companies and EZI. It was managed as a regular department within ILZRO from 1987 through 1990 by Marshall P. Roman and since then by John L. Hostetler under the supervision of Dr. Frank E. Goodwin, Vice Pres., ILZRO.

An effort to sell the patent estate and all rights was proposed in 1990 but abandoned when ILZRO determined none of the offers was acceptable. Mr. Hostetler was subsequently hired as Director effective Jan. 1, 1991.

Galfan License fees were increased in 1992 to improve Galfan start-ups by providing technical assistance to new licensees. The most significant addition to the technology package was the customized Line Operating Manuals.

License fees were increased again in 1994 to replace funding from previous sources and to pay sales commissions on licenses sold by Galfan Technology Sales Representatives. Agreements with six representatives who are responsible for Europe, Eastern Europe, China and India were negotiated and completed.

GTRC was operated at break-even in 1992 and 1993 and has a projected surplus for 1994.

PRESENT ORGANIZATION

The GTC organization is minimal, consisting of a Director, a secretary (part-time) and independent agents. The Director and the Secretary are regular ILZRO employees. The Galfan Technology Sales Representatives are private contractor agents paid a commission based on a percentage of invoiced and collected sales. Galfan Technology Transfer Contractors are private contractor agents paid fixed fees to provide technical services included in the Galfan licenses.

The Director's duties include:

- *Establish and maintain a Galfan Technology library.*
- *Establish and maintain regular communications with licensees, Galfan Technology Sales Representatives, Galfan Technology Transfer Contractors, Galfan Development Association Directors, etc.*
- *Write, edit and publish Galfan papers.*
- *Establish and maintain comprehensive, accurate and up-to-date files for each active licensee, Galfan Technology Sales Representative, Galfan Technology Transfer Contractor, etc.*
- *Prepare GTC Newsletters. Publishing and distribution to developed mailing lists and news releases to the media shall be out-sourced.*
- *Prepare Galfan Technology manuscripts.*
- *Edit and coordinate publication of all Galfan Manuals.*
- *Liaison with task forces, committees and associations.*
- *Direct the work of the Galfan Technology Transfer Contractors.*
- *Direct the work of the Galfan Technology Sales Representatives.*
- *Publish a Directory of Galfan Licensees and Services*

GALFAN TECHNOLOGY TRANSFER CONTRACTORS

New Galfan licensees become satisfied Galfan licensees through effective technology transfer and thorough personnel training, making new start-ups effective. Galvanizing with Galfan must quickly become a profitable venture. History shows that existing licensees will not meaningfully help new licensees on start-ups. GTC must therefore, develop, control and transfer its own Galfan technology package.

The face-to-face transfer of Galfan technology is done by Galfan Technology Transfer Contractors who must be thoroughly experienced and equipped to evaluate existing line conditions, make design recommendations and train personnel. They must also be prepared and equipped to offer consulting and technical services to the licensee beyond those included in the Galfan license fee.

Qualified Galfan Technology Transfer Contractors for sheet, wire and tube are already established. Others will be appointed as the need arises.

FOR GALFAN ALLOY:

GTC has a qualified candidate.

FOR GALFAN SHEET LICENSES:

Kohler Coating Machinery Corp., Greentown, Ohio
Att: Mr. Milt Blankenship

FOR GALFAN WIRE LICENSES:

Decktec, Inc., Canton, Ohio
Att: Mr. C. E. Decker

FOR GALFAN TUBE LICENSES:

Decktec, Inc., Canton, Ohio
Att: Mr. C. E. Decker

GALFAN LICENSE AND TECHNOLOGY SALES REPRESENTATIVES

Good research and development require generous funding from the sale of new licenses. To do this efficiently, a Galfan Technology Sales Representative in the market region is appointed to identify, qualify and sell licenses to new licensees.

GTC has already recruited and appointed six representatives who are well-known and technically qualified to sell Galfan licenses and Galfan technology. GTC must train and equip them so that they are well qualified to represent the Galfan technology and GTC must then support them so they are effective in their promotion of Galfan technology and licenses.

The current Galfan Technology Sales Representatives and the territories served by them are shown below:

- C.S.Primetech, Inc. — Peoples Republic of China
  Dean Di Chen
  Petaluma, CA

  Hongwu Liu
  Beijing, China (PRC)

- Miroslav Havrda — Eastern Europe and C.I.S.
  Prague, Czech

  Jerzy Kwiecien — Poland
  Warsaw, Poland

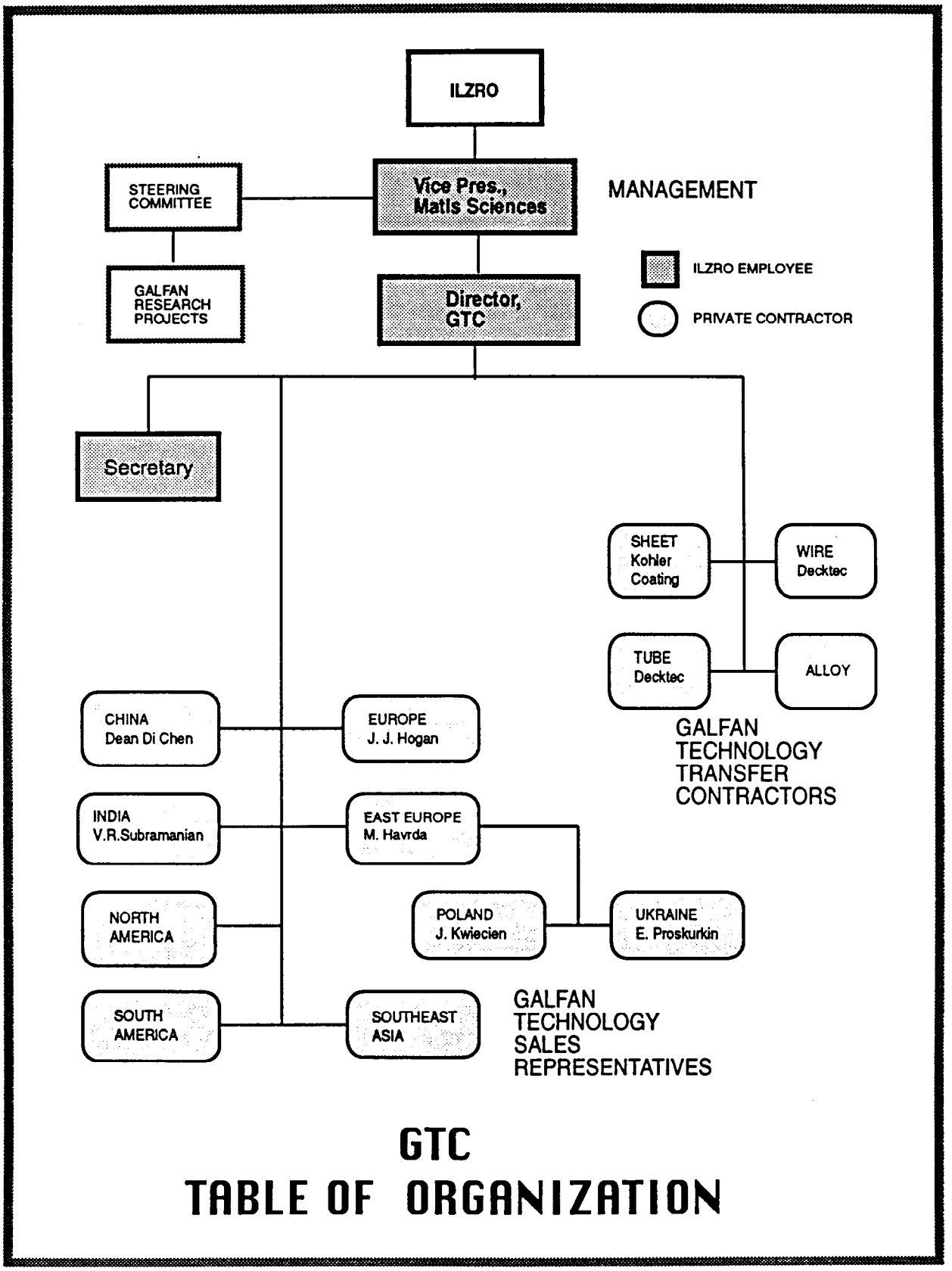
  Eugene Proskurkin — Ukraine
  Dniepropetrovsk, Ukraine

- Joe Hogan — EEC Europe and Mid-East
  Derby, England

- V. R. Subramanian — India
  New Delhi, India

GTC encourages the representatives to attend and participate in regional meetings of galvanizers to make Galfan very visible to the industry. GTC will especially encourage cooperation between Galfan Alloy Licensees and the Galfan Technology Sales Representatives.

Successful research and development also require good project management. ILZRO has amply demonstrated its expertise in this area so ILZRO shall manage all research and development projects.



GTC
TABLE OF ORGANIZATION

E FINANCIAL

GTC is a not-for-profit company. Its income is used to sponsor Galfan research, develop and transfer technology, provide technical support to licensees and development associations and to introduce Galfan into new market regions. Surplus funds are re-invested in these areas.

INCOME

GTC has two major sources of operating income:

1. Annual GTC Unitshares bought by Galfan Licensees, and
2. Initiation fees deducted from new license fees.

Additionally, ILZRO has allowed GTC to carry over the 1994 GTRC surplus.

INCOME FROM GTC UNITSHARES

One income source is from GTC unitshares sold annually to Galfan Licensees. A GTC unitshare is intended to pay for GTC's out-of-pocket cost to provide special services such as registration at regional and world-wide GTC meetings, regular transfer of technology regarding Galfan, the Galfan literature database and access to certain technical services available to owners of a GTC unitshare.

Additionally, GTC unit shareholders shall receive regular progress reports of all GTC-sponsored research progress reports during the tenure of the project. The Galfan license requires that ILZRO offers improvements to the licensee (and vice versa). GTC shall fulfill that requirement through the Executive Summary of each GTC-sponsored research project.

INCOME FROM LICENSE FEES

Fees charged for licenses are established by ILZRO because the license is an agreement between ILZRO and the licensee. Certain expenses shall immediately be credited to GTC from the license fees as follows:

- An initiation assessment is paid to GTC from the license fee for the basic cost of technology transfer to the new licensee and for the first year's GTC unitshare.

- A contribution to the advertising and promotion fund. This fund shall be used for media advertising, world-wide exhibitions, etc. The year 1995 shows an unusually high amount set aside to produce a multi-language four-color GTC portfolio and other related promotional material.

- A Royalty paid to ILZRO based on the license fee collected.

- A Sales Commission paid to the responsible Galfan Technology Sales Representative. If there is no contract requirement to pay a commission to a contract representative, an amount equal to 10% of the license fee shall be credited to GTC.

- Costs to produce of the Line Operating Manual and other associated technical services costs are paid to the appropriate Galfan Technology Transfer Contractor.

- A contribution to the legal fund that pays legal expenses to defend the patents, enforce the licenses, etc.

All remaining income from new license fees is designated for research and development projects in which GTC is the sole or major shareholder. About sixty percent (60%) is allotted to ILZRO-managed *basic scientific* research projects, the remainder (about forty percent) to ILZRO-managed *process or application improvement* projects or special market development technical services to GTC unitholders.

EXPENSES

The following tables show various fixed and variable expenses.

GTC's major strategy is to raise money for GTC-sponsored research and development rather than to build a large surplus. Surplus funds are re-invested in research and services.

Estimates for the next three years should be reasonably accurate but estimates beyond 1997 would be highly speculative.

NOTES

TABLE G.1

PROJECTED NEW GALFAN LICENSES

LICENSE CATEGORY	EXIST'G	YEAR				TOTAL 95-97	GRAND TOTAL
		1994	1995	1996	1997		
Alloy	21	1	1	2	1	4	26
Sheet	30	2	2	2	1	5	37
Wire	12	1	2	3	3	8	21
Tube	9	2	1	2	2	5	16
Small Parts	1	0	1	1	3	5	6
General	0	0	0	0	1	1	1
TOTAL	73	6	7	10	11	28	107

TABLE G.2

SCHEDULE OF PROPOSED LICENSE FEES

LICENSE CATEGORY	YEAR		
	1995	1996	1997
Alloy*	30,000	40,000	50,000
Sheet	175,000	175,000	200,000
Wire	70,000	70,000	75,000
Tube	70,000	75,000	75,000
Small Parts	35,000	35,000	35,000
General	35,000	40,000	50,000

* Based on ILZRO member

TABLE G.3

PROJECTED GROSS INCOME FROM NEW GALFAN LICENSE SALES

LICENSE CATEGORY	EXIST'G	YEAR				TOTAL 95-97
		1994	1995	1996	1997	
Alloy		30,000	30,000	80,000	50,000	160,000
Sheet		300,000	350,000	350,000	200,000	900,000
Wire		50,000	140,000	210,000	225,000	575,000
Tube		70,000	70,000	150,000	150,000	370,000
Small Parts		0	35,000	35,000	105,000	175,000
General		0	0	0	50,000	50,000
TOTAL		450,000	625,000	825,000	780,000	2,230,000

NOTE: All monetary amounts shown in US$

TABLE G.4

PROJECTED LICENSE FEES EXPENSES

	LICENSE CATEGORY					
CHARGE	ALLOY	SHEET	WIRE	TUBE	SM PTS	GEN
Commission	3,000	17,500	7,000	7,000	3,500	5,000
Royalty	3,000	17,500	7,000	7,000	3,500	4,000
Initiation	11,000	22,500	15,000	15,000	7,500	10,000
Technical	7,500	20,000	10,000	10,000	7,500	12,500
Legal	600	3,500	1,400	1,400	700	800
Advertising	750	4,375	1,750	1,750	875	1,000
Other	1,000	5,000	3,000	3,000	1,250	1,500
TOTAL	26,850	90,375	45,150	45,150	24,825	34,800

TABLE G.5

PROJECTED RESEARCH FUNDS AVAILABLE FROM NEW LICENSE SALES

	LICENSE CATEGORY						FOR
YEAR	ALLOY	SHEET	WIRE	TUBE	SM PTS	GEN	R & D
1995	3,150	169,250	49,700	24,850	10,175	0	257,125
1996	26,300	169,250	74,550	119,700	10,175	0	399,975
1997	23,150	109,625	89,550	134,700	30,525	15,200	402,750
TOTAL	52,600	448,125	213,800	279,250	50,875	15,200	1,059,850

TABLE G.6

PROJECTED GTC INCOME FROM INITIATION FEES FROM NEW LICENSE SALES

	LICENSE CATEGORY						
YEAR	ALLOY	SHEET	WIRE	TUBE	SM PTS	GEN	TOTAL
1995	11,000	45,000	30,000	15,000	7,500	0	108,500
1996	22,000	45,000	45,000	30,000	7,500	0	149,500
1997	11,000	22,500	45,000	30,000	22,500	10,000	141,000
TOTAL	44,000	112,500	120,000	75,000	37,500	10,000	399,000

NOTE: All monetary amounts shown in US$

TABLE G.7

PROJECTED SALES OF GTC UNITSHARES

LICENSE CATEGORY	YEAR 1995	1996	1997
Alloy	11	12	14
Sheet	13	15	17
Wire	5	7	10
Tube	3	4	6
Small Parts	0	1	2
General	0	0	0
TOTAL	**32**	**39**	**49**

TABLE G.8

SCHEDULE OF PROPOSED UNITSHARE COST

LICENSE CATEGORY	YEAR 1995	1996	1997
Alloy	3,500	4,000	5,000
Sheet	4,000	5,000	5,500
Wire	3,000	3,000	3,500
Tube	3,000	3,000	3,500
Small Parts	2,000	2,500	2,500
General	4,000	4,500	5,000

TABLE G.9

PROJECTED INCOME FROM UNITSHARE SALES

LICENSE CATEGORY	YEAR 1995	1996	1997	TOTAL 95-97
Alloy	38,500	48,000	70,000	156,500
Sheet	52,000	75,000	93,500	220,500
Wire	15,000	21,000	35,000	71,000
Tube	9,000	12,000	21,000	42,000
Small Parts	0	2,500	5,000	7,500
General	0	0	0	0
TOTAL	**114,500**	**158,500**	**224,500**	**497,500**

NOTE: All monetary amounts shown in US$

TABLE G.10

PROJECTED GTC INCOME

INCOME SOURCE	YEAR					TOTAL
	1993	1994	1995	1996	1997	
Fund Unit Shares	75,000	25,000	114,500	158,500	224,500	497,500
Initiation Fees (1)	204,960	375,000	108,500	149,500	141,000	399,000
Carry-over	25,568		102,000	52,000	46,300	200,300
TOTAL INCOME	305,528	400,000	325,000	360,000	411,800	1,096,800

Note 1: Initiation Fees in 1993 and 1994 are gross license sales.

TABLE G.11

PROJECTED GTC OPERATING EXPENSES

EXPENSE CATEGORY	YEAR					TOTAL
	1993	1994	1995	1996	1997	
Salaries & Benefits (1)	105,000	112,500	130,000	145,000	160,000	435,000
Facilities			14,000	15,400	16,940	46,340
Communications			20,000	22,000	24,200	66,200
Printing	25,684	10,000	12,000	13,200	14,520	39,720
Meetings (2)	20,702	31,500	25,000	30,000	40,000	95,000
Other Services (3)		63,000		5,000	7,500	12,500
Professional Services (4)			12,000	12,600	13,230	37,830
Travel	35,427	50,000	40,000	45,000	65,000	150,000
Membership		1,000	5,000	5,500	6,000	16,500
Papers and Library			10,000	12,500	15,000	37,500
Other	45,391	5,000	5,000	7,500	10,000	22,500
TOTAL EXP	232,204	273,000	273,000	313,700	372,390	477,750

PROJECTED SURPLUS	-27,244	102,000	52,000	46,300	39,410	

Note 1: Based on full-time Secretary in 1996

Note 2: Meetings include Licensee meetings and meetings registrations.

Note 3: Other services in 1994 include sales commissions and technical services.

Note 4: Includes accounting and audits.

Note 5: All monetary amounts shown in US$

F LICENSING

GALFAN is three things:

- Galfan is a patented **alloy**, Zn-5%Al with mischmetal,
- Galfan is a galvanizing **process** and **product**, and
- Galfan is **technology and know-how**

Given the technology together with the proper equipment and skills, producing Galfan alloy is a straightforward matter. The processes used for the various forms of galvanizing with Galfan are essentially similar to those used for regular galvanizing. Without the benefit of additional technology and know-how however, attempts to successfully make Galfan alloy or Galfan products will fail or will produce products of inferior quality.

Alloy and galvanizing production practices are part of GTC's expertise. its primary function is to produce a *Galfan Technology* that galvanizers will want to buy to maximize the benefits and profits of galvanizing with a Zn-5%Al alloy. That technology and know-how is licensed to qualified alloyers and galvanizers.

Galfan technology is information that equips the licensee to successfully hot-dip galvanize steel with Galfan alloy. GTC gets the needed information from ILZRO research, its own experience, consultants, licensees and other galvanizing resources. GTC must gather pertinent information, synthesize it and package it in a way that is affordable, credible and profitable. *Technology has commercial value only when someone is willing to buy it.*

Past Galfan licenses granted the galvanizer the right to buy and use the patented alloy and to use the registered Trademark. Many of the patents will expire before 2000. Furthermore, many licensees use their own trademark to identify their Galfan product.

Clearly, a different approach must be used to continue development and dissemination of technology in the future.

THE LICENSED PRODUCT

New licenses grant the right to receive and use GTC technology instead of rights to use the ILZRO patents. They grant those rights for a period of ten years (with automatic five-year renewals) rather than for the life of the patent. Additionally, new licenses require the identification of all Galfan alloy or product specifically as 'Galfan' although use of the licensee's own trademark or logo may be used in addition to the Galfan identification. Further, the licensee agrees to use only alloy purchased from ILZRO-licensed alloy suppliers.

The new licensee is entitled to the current body of Galfan technology plus a GTC unitshare for the year the license becomes effective. The licensee must then purchase a GTC unitshare each year thereafter to acquire new technologies and other services offered by GTC.

GALFAN TECHNOLOGY SALES REPRESENTATIVES

The success of the GTC plan depends largely on GTC's ability to sell new Galfan licenses. Selling new Galfan licenses is the responsibility of the Galfan Technology Sales Representatives. Each sales representative's job therefore, is important to the success of the GTC plan.

The plan will work as proposed if the 28 new Galfan licenses listed in Table G.1 are sold in the next three years as shown. It is important to remember that these 28 licenses must be sold to *new licensees*. Some of the Galfan licenses sold before 1991 offer to license additional lines at a discounted fee, therefore extending existing licenses will not produce the *income per license* shown. The benefits included with the new licenses cannot be granted to licensees except at the new prices. These benefits are, however, available to existing licensees for a fee.

GTC must provide strong support to the Galfan Technology Sales Representative's program to assure these license sales. Customized strategies or programs will be needed for each territory because of the diversity in

market conditions. A strategy for each territory shall be developed before the end of June 1995.

GALFAN TECHNOLOGY TRANSFER CONTRACTORS

There is a truism that says an owner's first few hundred kilometers in a new car will determine whether he likes it or not for as long as he keeps it. Is this cause or effect? Veteran equipment start-up engineers affirm that if a new process or machine starts up badly, no matter how well it is made to perform later, the operators rarely change their first impression and unfortunately, there is a second truism that follows, *The system will only work if the operator wants it to work.*

These two truisms are particularly pertinent to Galfan production. There are always pioneers who will overcome any obstacle to do something that has never been done before. After that incentive is gone, however, start-ups are critical.

For that reason, GTC must help to make a new licensee's start-up as trouble-free as possible. Two keys accomplish this:

> *1. Provide a written manual that describes how the line is to run; first, in a general overall mode and then, in detail, how each of the elements, processes and pieces of equipment is to be controlled. It must also quantify the expected quality, output, etc. results.*
>
> *Teach the operating personnel how to understand the function and operation of the line's processes and its components then train them how to control the processes and the process equipment.*

GTC provides a customized Line Operating Manual for each new licensed line. Upon completion of the licensing procedure, the Galfan Technology Transfer Contractor and a qualified technician or engineer representing the licensee write the manuscript for the manual, describing in detail how to control each process in the process section of the licensed line. GTC then edits, publishes and distributes the manual to the Licensee. It becomes the proprietary property of GTC and that Licensee.

G OPERATING POLICIES

PURPOSE

The Galfan Technology Center (GTC) is the successor to the Galfan Technical Resource Center (GTRC) which managed the Galfan program for ILZRO since 1987. GTC will be more proactive and offer more services to GTC unitholders than GTRC did for Galfan licensees because it:

- will develop new Galfan technology faster;
- expands and improves technology transfer;
- provides encouragement and technical support for regional Galfan market development associations; and
- provides an organization to sell new Galfan licenses, the major income source.

Additionally, GTC shall raise significant money and other resources to sponsor Galfan research and development that will directly create new Galfan markets and promote expansion of existing applications.

OWNERSHIP AND MEMBERSHIP

The Galfan Technology Center is totally owned by International Lead Zinc Research Organization, Inc. (ILZRO), a non-profit organization. GTC members are qualified Galfan licensees who buy a non-refundable GTC unitshare issued for one (1) calendar year. Unitshares are available only to Galfan licensees on record as of December 31 of the year before the unitshare year or to new licensees.

REGULAR MEMBER

Most Galfan licensees are licensed for one production line in one category. A regular member is a single-line, single-category Galfan licensee who has bought and paid for a unitshare. Regular unitshares are available at prices based on the Galfan license category using the following schedule:

Galfan License Category	*Cost of Regular 1995 Unitshare*
Alloy	US$ 3,500
Sheet	4,000
Wire	3,000
Tube	3,000
Small Parts	2,000

MULTI-LINE MEMBER

Some Galfan licensees are multi-line licensees, i.e., they are licensed to produce Galfan products on more than one production line. The price for a GTC unitshare to multi-line licensees shall be computed using the following schedule:

a) An amount equal to the regular unitshare price for the license category, plus

b) An additional amount equal to 25% of the regular unitshare price for the license category for each additional line.

Multi-line members receive one unitshare but may designate one representative for each line who shall be included on the regular mailing list for most Galfan information and other correspondence.

MULTI-CATEGORY MEMBER

Some Galfan licensees are multi-category licensees, i.e., they are licensed in more than one category. The price for a GTC unitshare for multi-category licensees shall be computed using the following schedule:

a) An amount equal to the regular unitshare price for the highest price license category, plus

b) An additional amount equal to 50% of the regular unitshare price for each additional category.

Multi-category members receive one unitshare but may designate one representative for each category who shall be placed on the regular mailing list for all Galfan information and other correspondence.

NEW LICENSEE MEMBER

A new Galfan licensee receives a unitshare for the year in which the Galfan license agreement is signed, the fee being paid from the initiation fee credited to GTC from the license fee. The new licensee shall pay the regular price for subsequent unitshares.

MEMBERSHIP LEVELS

Regular membership is the only level of GTC membership. There are no associate or secondary memberships. All information addressed to *GTC Members* is to be considered as *proprietary and confidential* to GTC and its members. Galfan information distributed by GTC that is not proprietary to GTC shall be marked for *Galfan licensees.*

RESEARCH AND DEVELOPMENT PROJECT MANAGEMENT

Research and development is at the core of the GTC plan. One of GTC's major activities is to raise money to fund GTC-sponsored research and development projects. Management of the research and development budget, evaluation of projects nominated, recommendations for project consideration and final decisions following unitholder voting is done by the GTC Research and Development Committee. See Figure 7.1

One committee member from each region shall be selected by the GTC members at the world-wide Galfan Licensees Meeting in alternating years starting in June 1995.

Committee members shall serve for two years beginning January 1 of the year following their selection. Three interim committee members to serve for the year 1995 shall be selected from the responses from the GTC 1995 Unit shareholders. The fourth member shall be appointed by the chairman.

ILZRO shall manage all GTC-sponsored research and development as regular ILZRO projects.

TASK FORCES

GTC may use temporary task forces whenever they are the more effective or efficient way to staff a project. Task Forces may be staffed by GTC members, research contractors, and/or Galfan Technology Transfer Contractors. Approved suppliers and other agencies who can provide needed expertise or resources for the project may be asked to participate when needed. Results of work by GTC task forces shall be proprietary and confidential to GTC and its members. Task force members who are not GTC unitholders must sign a Secrecy Agreement.

TERMINATION

GTC membership is automatically terminated when the unitshare expires.

GTC membership may be terminated by written notice from GTC for causes such as:

- failure to pay the full subscription for unit shares by the due date;
- violation of confidentiality by the unitholder;
- violation of the Galfan license; or
- termination of the Galfan license.

No member resigning, forfeiting or otherwise terminating GTC membership may assign or transfer his membership nor any privilege of membership. If a GTC member chooses not to purchase a unitshare for the next year, the terms for any of its employees serving on task forces or committees may be terminated. In such cases the unexpired terms shall be filled by appointment by the group's chairperson.

REPRESENTATION

Each GTC member company shall designate one person as its official representative to speak and vote on its behalf in all activities for which it is entitled to be represented. The GTC member company may change its representative by written notice to GTC's Director. The annual Galfan Directory of Licensees and Services shall clearly identify and feature GTC members and representatives.

GTC MEETINGS

GTC shall meet in alternating years in conjunction with the world-wide Galfan Licensee Meeting. Registration fees for each GTC unitshare official representative to GTC meetings shall be waived. Other employees of GTC unitholders may attend but they will be assessed a registration fee to cover supplies, facilities and activities. The general Galfan licensees will meet first. The GTC unitholders' sessions that follow shall be limited to GTC unitholders.

Other GTC Unitholders' meetings, world-wide or regional, may be called as necessary.

GTC UNITHOLDERS AND OTHER GALFAN LICENSEES

The GTC plan desires that every Galfan licensee buy a GTC unitshare and become a GTC member but the Galfan license agreement does not require the licensee to do so. GTC must make allowance, therefore, for those Galfan licensees who might choose not to be GTC unitholders. ILZRO's intention is to fulfill its obligations to licensees but it must also insure Galfan's continued growth by generating the resources to sponsor the substantial new research needed. GTC's plan is the best way to meet this objective.

There should be no conflict between Galfan licensees who become GTC members and those who choose not to. Whether a licensee chooses to become a unitholder and member of GTC will probably be based on whether the licensee wants to participate in the decision-making and the immediate benefits of new GTC-sponsored research.

MEMBERSHIP APPLICATION

A two-part GTC unitshare purchase or subscription form shall be distributed to all Galfan licensees. The top of the form (Offer) is the qualifying information from our records that establishes the eligibility and description of the Galfan licensee. The bottom of the form (Response) is the Galfan licensee's application to buy a unitshare and become a GTC member.

The forms are distributed after October 1 and responses returned before December 15, 1994, will be listed as a GTC member in the 1995 Directory. Upon receipt of the licensee's response, GTC shall submit an invoice dated January 1, 1995, to the licensee with net 30 day terms. The unitshare shall be issued (and the licensee becomes a member of GTC) when the full invoice payment has been received. Unitshares for 1995 shall not be for sale after January 31, 1995, except to new licensees.

The GTC Business Plan and this document are intended to provide a licensee with all the information needed to answer any questions about GTC's plan. Any questions not answered should be directed to:

GALFAN TECHNOLOGY CENTER
Attn.: John L. Hostetler, P.E., Director
Telephone: 919/361-4647
Facsimile: 919/361-1957

EUROPEAN

GALFAN

DEVELOPMENT

ASSOCIATION

J J Hogan. - November 1994.

European Galfan Development Association.

EGDA.

Following the proposal submitted for full discussion by the delegates attending the European Galfan licensees meeting in Luxembourg on Friday 4th November.

Please find the revised EGDA proposal submission for your consideration. This revised proposal takes into account the comments made by the various delegates, for which the proposer thanks all concerned for their valuable contribution.

Introduction.

Following the introduction of the **GALFAN®™** alloy to the market for the improved galvanising of steel sheet, wire and tube in the early 1980's, each GALFAN® producer has adopted their own sales and marketing policy best suited to their own particular production and markets.

This stand alone policy has for some years now brought about the success we see today of the use of GALFAN® in the market place. Through the various GALFAN® meetings each manufacturer and GALFAN® licensee has had the opportunity to enter into discussions of a mutual nature concerning their general applications to which the GALFAN® alloy is applied. The research and development by the various licensees has been of great benefit to other licensees.

Further the GALFAN® Bath Management Committee, GBMC, who meet on a regular basis have agreed on procedures to ensure the continuous quality of the alloy in the bath. The discussions held at the GBMC are of immense value to all licensees and clearly demonstrates the true advantage of "working" together to a common aim.

In North America, particularly the USA, the establishment of the NAGA (North American Galfan Association.) has proven to be of immense value and success in the promotion and acceptance of GALFAN® products. In Europe, the most established GALFAN® market by number of licensees, various proposals have been submitted in the past to establish a EGDA (European Galfan Development Association.) all of which have fallen by the way side for various reasons.

The timing may now well be right to review the current situation with the objective of setting up a EGDA.

ILZRO and the GTC has given its full support to the establishment of an EGDA.

Objectives.

As with any association the objectives must be established by members of the association. The following objectives are therefore initial proposals as the basis of the objectives of such an association. The final objectives are to be agreed upon the setting up of the EGDA.

For consideration :

Objectives:

The first and prime objective is to increase the sales of GALFAN® coated products.

This objective is of course the most obvious, however must be listed to ensure that we do not loose sight of the basis objective of setting up the EGDA.

To make aware those markets which offer the greatest potential for GALFAN® .

For example, the automotive industry. In the past when approaches have been made to the Ford Motor Company they have shown a great interest in all the benefits offered by GALFAN® coated sheet, wires and tube, however they are not prepared to specify GALFAN® products until it was established that a competitive sourceing of supply was in place. This is I believe now the case, therefore an independent body/organisation EGDA should make FORD aware of the situation.
As more licensees set up GALFAN® production the more available the GALFAN® product becomes, thus answering the competitive supply source requirement by the automotive industry.

Other users have in the past encountered the same situation, for example the white goods industry. Those manufacturers of say washing machines have in a small way being buying GALFAN® from local sources but as companies adopt the "global" sourceing methods within their purchasing departments they now need to know that there is more than one potential supplier of the GALFAN® needs.

Thus the second objective must be to make the potential markets fully aware of the benefits of GALFAN® and of its availability.

To ensure that GALFAN® is included in all revisions of the European and National standards.

Slowly but surely within Europe the barriers are breaking down concerning the universal use of standards. The best example of this is in the quality Control standard ISO 9000. Not so many years ago each country within the European Community set up their own quality control standards, e.g. BS 5750.
However today most companies within the EEC are working within or towards the ISO 9000 standard.
Over the coming years the same situation will happen to other national standards and all standards will be fully harmonised.

GALFAN® is already included in some EC standards, in the main thanks to individual efforts by GALFAN® licensees. Further efforts are needed to be made to ensure GALFAN® is included in all revisions of EC standards. Not just for the products in production today but for other products which may well be of potential applications for GALFAN® be it sheet or wire.

To lift the image of GALFAN® in response to other competitive products.

In Europe there are two markets for GALFAN® product. Sheet and wire, at present no production officially exists for GALFAN® tube. Each sector, sheet and wire has of course its own competition. The situation for wire is slightly different than in sheet as Galvalume is not used in wire.

Many companies including those end users perceive Galvalume as a better product than GALFAN® . In part this is due to the considerably higher cost of the Galvalume license. Like so many things in life you perceive the more you pay the better expectations you have of the value of that product.

In the cost of the very expensive Galvalume license, there is included full marketing and sales support technical assistance start up agreements and of course a levy on each tonne produced. By purchasing the GALFAN® license it may be likened to buying a BMW. You get the very basis car but you have to pay for the extras, whereas with Galvalume you get all the extras whether you want them or not.

GALFAN® is I believe a superior product to Galvalume, offering a number of advantages over this product. It is this message we need to get over to the end users.

The only way to sell a product is to knock on doors. By this I mean that visits must be made by agreement to those potential markets whereby it is felt that a potential exists for GALFAN® . As per the examples already mentioned, the automotive industry.
It was noted during the European GALFAN® meeting that the single largest application of GALFAN® was in the construction industry. This market needs to be made fully aware of the potential of GALFAN® thus ensuring further and future sales increase. Like wise the white goods market needs to obtain greater awareness of GALFAN® and its many advantages.

The two above mentioned products apply of course to the sheet markets, but the wire industry is an important industry and must receive the same support in terms of the automotive industry, and construction industry. GALFAN® coated building wires as one example.

Under the proposed second objective i.e. market awareness one must include some form of advertising. Initially I would propose a brochure similar to that produced by the NAGA but listing those European GALFAN® licensees.

Further advertising may be by way of editorials in selected trade journals agreed by members of the association.

For the third objective visits would be made to the various National and European Standards offices to ensure that no revisions of the standards is missed. It is hoped and expected that members of the association would be able to assist in this task.

Membership.

Membership would be restricted.

Initially I would propose that membership be limited only to GALFAN® licensees. both productive and non - productive.

To those companies currently in production of GALFAN® products membership of the EGDA would provide a support to their existing marketing and sales efforts. The EGDA is not intended to replace existing sales and marketing efforts but to provide an independent back up to those efforts.

To those companies not at present in GALFAN® production it is hoped that the efforts of the EGDA would bring in enquiries thus prompting early entry into GALFAN® production.

There is of course the domino effect. The more available GALFAN® is in the market place the greater the demand will be for GALFAN® as the markets become more aware of the advantages GALFAN® has to offer.

The benefits of membership would be;

1. Listing within all advertising

2. Receipt of all enquiries relating to GALFAN® products.

3. Names provided to potential clients following those visits as listed above.

4. Participation in the EGDA meetings, proposed as two meetings per year, or as agreed after the first meeting.

5. Full backing and support of ILZRO and the GTC.

Costs.

Currently in the EC we have 20 licensees. The costs must therefore be realistic and affordable within these numbers.

There are four areas of costings which would determine the final cost of membership. Firstly the number of companies agreeing to take part and to become members of the EGDA. The more join the cost decreases accordingly. The three other areas are, salary, administration and travel expenses.

For your consideration the proposal is:

Salary.

For initially one person as heading the EGDA.

A basis salary of $30,000. per annum. With an annual review.

Administration:

To employing one part time secretary	:	$ 7500
Office accommodation	:	$ 3000
Stationery/Telephone/Fax facility	:	$ 3000
Brochures	:	$ to be agreed

Travel:

Fuel, hotels etc.	:	$ 10,000.

Thus the initial costs (excluding the cost of publication and printing of a brochure) would be say $53,500.

There will be no distinction between producers, non-producers and alloy suppliers. Therefore membership costs would be:

Full membership	:	**$ 6,000 per year.**

This assumes the minimum membership of 10.

It is accepted that the task ahead is considerable for one person, and that in an ideal world there should be three people to cover the whole of the EC. However I am mindful of the overall costs in terms of the limited number of potential menbers of the EGDA.

I would therefore propose that to avoid further delay of the setting up of the EGDA that for the first year the proposal as stands be accepted with a review after one year of the establishing of the EGDA.

It is hoped and anticipated that each member of the EGDA would give what ever assistance may be required to ensure the success of the EGDA and its longer term future.

About the Proposer.

Mr J J Hogan has been involved with GALFAN® since 1984. Whilst this has been mainly involved with GALFAN® in term of wires and the potential application of GALFAN® on wire. Over the past year or so Mr Hogan has become increasingly involved with all GALFAN® products and now acts as the, European Technology and License Transfer Representative for the GALFAN® Technical Centre and ILZRO.

Mr Hogan has signed all the required agreements with ILZRO in connection with GALFAN® . Several papers have been written by Mr Hogan on the subject of GALFAN® of which a joint paper was presented at the '89 Wire Industry Exhibition at Atlanta along with various presentations to other organisations.

Mr Hogans links with ILZRO would be of considerable benefit to the potential of a EGDA in so much as the direct contacts with ILZRO and the GTC.

Having read this proposal, if you are agreed, I would ask you to complete the following application form and return to ILZRO.

I thank you for you time and attention to this matter.

J J Hogan.

Nov.'94.

To:
ILZRO
P.O Box 12036
Research Triangle Park
North Carolina
NC 27709
USA.

European Galfan Development Association

Application Form.

Our company..... represented by..... wishes to take up full membership of the **EGDA** (European Galfan Development Association.) As per the proposal submitted by Mr J J Hogan. Nov. '94.

It is understood that membership is limited only to those companies who are GALFAN licensees.

The initial cost of membership is $ 6,000 per annum, and conditional of the minimum number of ten members. Our company will be invoiced upon set up of the EGDA and will be advised of other members of the EGDA.

Signed by .....

Please print name .....

on behalf of:

Company ; .....
Address : .....
.....
.....
Post Code : .....
Country : .....

Telephone : .....
Fax : .....

To:
I L Z R O
P.O Box 12036
Research Triangle Park
North Carolina
NC 27709
USA.

European Galfan Development Association

Our company ..... represented by ..... does not wish to accept the proposal submitted by Mr J J Hogan. Nov. '94.

We are / are not# interested in the establishment of a EGDA.

Please delete as appropriate.

Our reason for rejection of this proposal is :

.....
.....
.....
.....
.....

Signed by .....

Please print name .....

on behalf of:

Company ; .....
Address : .....
.....
.....
Post Code : .....
Country : .....

Telephone : .....
Fax : .....