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METALLURGICAL INSTITUTE "HASAN BRKIĆ" ZENICA

a Case Study of Co-operation with Industry 1/

by

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The Metallurgical Institute "Hasan Brkić" Zenica was founded in 1961 with the aim to cover the increasing R&D needs of the country,s steel industry. Problems arising from specific properties of domestic raw materials like iron ores, fluxes, refractories, foundry sands etc. required intensive investigations to develop processes and procedures how to use them with optimum technological and economic efficiency. Furthermore, the intensive development of the steel industry involving many new installations and equipment like agglomeration plants, blast-furnaces, steel making furnaces, rolling mills etc, required carefull studies to achieve the originally designed production figures as well as a satisfactory quality of the products. All these problems tdgether with the general necessity to increase the efficiency of the steel industry, made the organization of an institution professionally concerned with the research of steel metallurgical problems highly urgent. Due to basic orientation towards applied resea.ch the decision was made to select the site for the institute in Zenica as the center of Yugoslav steel industry. The location of the institute in Zenica should enable the research staff to keep everyday contact with the production engineers and experts in order to be informed about the industrial problems to be selected for research programming.

The elaboration of the master programme for the design and implementation of the institutes facilities was based on some preparatory

actions like following:

1. Selection and set up of the research programme
2. Set up of the structure of the organization
3. The design of the laboratory and pilot premises and offices as well as the selection of corresponding equipment.

The starting point for the establishment of the research phylosophy was the classification of the metallurgical research activities in the well known 4 segments like:

Process research
Product research
Metallurgical engineering studies
Fundamental research

Each of these segments being possibly a subject of research programme a proper selection is to be made having in mind the general goals of the institute.

Process Research involves the investigations of the steel metallurgical extraction, processing and refining processes like beneficiation and preparation of the blast furnace burden materials, reduction and oxydation processes, hot and cold forming processes etc. with the general goal to find more efficient technological solutions. The revolutionary changes accomplished in the last few decades like the use of oxygen, vaccum metallurgy, continuous steel casting, high speed rolling mills and alike are good example of achievements of this kind of research. Such research is carried out in large scale experiments with very high investment and experimental costs being accessible to big organisations in highly developed countries. It seemed to be unrealistic for a country like Yugoslavia to start with research with the strategic goals

to develop new processes and equipment. It is more likely that the actions in this field should be oriented to some more realistic goals like:

a) Keeping informed about the recent state and the trends of development in the world to be able to make a proper selection of processes and equipment for the modernization of the existing and for the construction of the new steelmaking industries. The solution of this problem requires a will organized information and documentation service, as well as the various methods of contacts with the world leading professional organizations.

b) The adaptation of the technology transferred from developed countries to the domestic conditions taking into account some specific factors of influence arising from domestic raw materials, energy supply, human attitudes etc. in order to achieve the productivity rate and economic efficiency, or other parameters of performance as those being accomplished with similar processes and equipment in the well established industries in the world. This type of research can be mostly performed by proper industrial esperimentation, involving carefull monitoring and registration of the relevant parameters like temperature, pressure, time, quantities etc. As examples of this kind can be mentioned: the blast furnace investigations, time studies in the rolling mills, establishment of heat balance of the metallurgical furnaces etc. For this type of research one has to provide the research teams under the leadership of some senior engineers with a well established industrial experience, Such teams are to be equipped with appropriate transportable instrumentation

to be used for various measurements on the spot.

c) Laboratory and pilot plant experimentation is to be provided for such problems of process research, the solution of which could hardly be expected by the others, i.e. outside of the country. This particularly applies to the problems specific to the domestic resources, primarly iron ores, coals, refractories etc. The beneficiation of iron ores requires the development of the technologies appropriate to their mineralogical, chemical and physical properties. This was the reason to decide to organise this type of research and to implement the adequate equipment for pilot plant investigation.

Product Research seems to be the most important one due to some particular reasons. This type of research is concerned with the intensif investigation of steel materials in order to improve the quality of the existing product-mix or to develop new steel produts being not produced before.

The econonic efficiency of the steel industry is substantially influenced by two factors: size cost degression and the price value of the product mix. The size cost degression is hardly to be afforded in the smaller and developing countries because it requires very high capacity production units like: extraordinary big blast-furnaces, oxygen converters, rolling mills etc. having the annual capacities of the order of more millions tons per year. Being capital intensif and requiring very broad markets, such units are mostly beyond the economic potentials of countries like Yugoslavia. So, the solution of problem of economic efficiency is more likely to be reached through a higher level special grade product mix being higher priced and contributing more to the national economy. The realization of such a higher grade product mix is only

possible through a well established production technology as well as well established quality control systhem being substantially dependent of an adequate research and development activity. This particularly because the technological transfer from developed countries in this field has many obstacles arising from conflicting tendencies on the world market of the steel products.

From the point of vieux of the organization, this type of research is more feasible to be accomplished within the framework of a research institution. It requires pilot installations for melting, shaping and processing of steels and alloys, as well as a set of well equipped laboratories being able to follows chemical and structural changes of the metals and alloys through the technological transformations, as well as to determine their properties. This type of experimentation has economic advantages due to the fact that the production of small experimental heats in the range of 50 - 100 kg weight is highly informatif, but many times less costly than the experimentation on an industrial scale at steel melting furnaces, rolling mills etc. The informations obtained through such experiments can save high costs of industrial experimentation but can supply the substantial data necessary to establish the corresponding production technology. An improvement of the deoxydations practice as well as the investigations of new type complex deoxidizers, the metallurgical behaviour of alloying additions, the new combinations of chemical composition of some new steels and alloys, the determination of basic parameters for hot and cold working of steels and alloys are some outstanding examples of this type of research.

In the field od Metallurgical Engineering Studies, there are some topics being of particular importance for the countries being in the course of developing their steel making and steel processing industries. The elaboration of the feasibility studies for the modernization of the existing

as well as for the erection of new industry providing proper selection of processes, capacities and products, supplied with corresponding techno-economic analysis is a subject very frequently requested by the industry or governmental bodies. The availability of such studies before contacting the supplyers of equipment is very useful giving impartial proposals not biassed by commercial or some other interests. Another type of research belonging to this groups is the investigation of performance of metallurgical furnaces, efficiency of their heat economy and the preparation of proposals for the corresponding improvements. The same applies to the problems of safety of work in metallurgy being an urgent problem in the metallurgical engineering studies.

As far as Fundamental Research is concerned one should cleerly have in mind what are the basic objects of this type of research in a developing country. The fundamental research as a method to strenghten theoretical knowledge being the basic condition for developing the research capabilities, is justified, but this kind of activity should not be excercised beyond the human and economic resources of the country. In the case of metallurgy the investigation of some basic laws of physical chemistry and physical metallurgy seem to be indispensable for an adequate research quality as a whole. In this category could be involved also the development of new methods of chemical, physical, mechanical etc testing metallic materials the mastering of which is the basis for a succesfull solution of the R&D problems.

Having in mind all the types of research mentioned above the appropriate organizational structure has been developed involving following organizational units:

DIVISION FOR LABORATORY RESEARCH including Metallographic-, Physical-, Mechanical Testing-, Chemical-, Mineralogical- and Ceramic Laboratories.

DIVISION FOR TECHNOLOGICAL RESEARCH including Departments and Pilot plants for C e Benefication a ' Agglomeration, Melting of Steels and Alloys, Hot and Cold forming by rolling, forging, pressing, drawing of rods and wires, Heat Treating.

DIVISION FOR METALLURGICAL ENGINEERING including Department for Feasibility Studies and Consulting Services, Studies of Heat and Metallurgical Furnaces, Safety of Work in Metallurgy and Computer Center.

DIVISION FOR METALLURGICAL EQUIPMENT ENGINEERING AND MAINTIENANCES including Design office, Machine Shop, Electrical and Electronic Repair Shop, Maintenance of the Buildings.

DIVISION FOR ADMINISTRATION including Research Administration and Planning as well as the other Management Functions.

All these Divisions are situated in five specially designed buildings with a total of 12000 m^2 working aerea. The buildings are located on an aerea of 60000 m^2 in the central part of city Zenica at a distance od 1 km from the Iron & Steel Works Zenica being expanded to a steel capacity od 2,6 mil tons/year.

The present staff of the Institute amounts 305 employes, 104 of them having a University degree. Beyond this, the Institute engages still 150 experts from the industries and universities as part time collaborators. The present volume of R&D services amounts slightly above an equivalent of 3 millions US Dollars per year consisting of an average og 50 to 60 finished research projects per year. The total number of finished R&D projects in the period of 15 years amounts more than 750 dealing with different problems of steel metallurgical process, product, engine-

ering and fundamental research.

The intensif growts of Institute's capabilities and their activities could hardly be achieved without an adequate cooperation with the industry being the basic consumer of Institute's services. Since the start of its functioning the Institute established its relation with the industry on a contract basic, it means, a contract for every research project. Through such contracts the obligations of both partners are stipulated. The Institute is obliged to give the R&D service within the stipulated terms of reference and according to the up to date standards of knowledge, the offered solution being the subject of acceptance by a group of experts nominated by the customer. The customer is obliged to pay for the services in the way and amount as agreed upon in the contract, Beyond this, the Institute is obliged to treat the research results as confidential matter, the publication of which being the subject of approvment of the customer. In the case of a result being subject to a patent, the relation between the two partners are to be ruled by mutual agreement and by the existing laws.

In order to be able to establisl such a "business like" relations with the industrial companies one has to provide some basic conditions. First of all, the industrial management has to be "research minded" expecting the solution of their problems through R&D services, and beyond this, it has to have the confidence in Institute's capabilities by engaging him for the solution of the corresponding problem. The competition for the orientation of the industrial management to the research services, as well as for the corresponding contracts, is one of the basic tasks of Institute's management. Some experiences acquired in this respect seem to be useful to be given in more detail.

In appointing the research staff attention is to be paid to the researchers with an industrial experience. A number of experienced experts, able

to be the partners with the industry seems to be indispensable, particularly in the early stages of the organization of a research institution. This type of researchers fills the gap between university professors or theoretical scientists and industrial management. It helps to the scientists to be more pragmatic and can be sufficiently convincing in defining the research projects adjusted to the corresponding needs of the industry. The appointment of scientists with a higher academic level, doctors, etc, should come in a later stage when the research activity reaches a certain level being concerned with the problems the solution of which requires more sophisticated methods.

In analysing the problem of relation between the research institute and industry it seems to be useful to bear in mind three stages of the R&D activity. This are: research programming, research process and application of research results, a close cooperation in all three stages being indispensable for a succesful result.

Research programming means the selection of research projects and their set up. There are two different situations which may arise in setting up a research project. Either an industrial company summons the research institute for solving a particular problem, ore the institute submits a proposal to a production enterprise. In the first case, the institute, being in a defensive position, has to be able through collection of necessary background informations to set up a research program being suitable to meet the customers needs. In the case of deficiency af adequate researchers, engineers or technologists, it is recommended rather to try to hire some experts from outside of the institute, for instance, from University or industry as part time collaborators, if available, then to refuse the order. One has, namely, to bear in mind that the readiness to help to some industrial company in trouble shooting some urgent problem helps very efficiently to establish mutual

confidence and fair business relation in the future.

In the case of absence of the summons from the part of industry the research organization should be rather agressive then to wait for the orders. In this case one has to submit the proposals for the research projects which will meet the industrial needs and as such will probably be accepted. Two elements are necessary for preparation of such proposals: the knowledge of the existing and future problems of particular industrial company, as well as the state and trends of development in this particular field on the international level. The informations on the current problems are to be collected through direct contact with industrial engeneers and management, by interviewing them and through the direct visits to the production shops, or through study of corresponding documents like development programms, production and quality control reports etc. The location of the Institute in the industrial aerea, and not in big or capital cities proved to be very useful for this type af activity. Based on all these informations one can elaborate the proposals of research projects which meet the needs of the corresponding industry.

The organization of an adequate information service proved to be very helpful in applying for research projects. Having in mind the particular production activity of an industrial company, the institute prepares an information bulletin indicating the current publications which may be of interest for the technical staff of potential customer, giving them the possibility of supply of these papers. Promoting the interest for the development on the international level in a particular field, one stimulates the technical staff and management to apply for similar results in their own production activity and that is a step towards summoning the research institute for corresponding research project.

The planning for the future in the industry of developing countries is often more concerned with production quantity figures. then with the quality of products and with the technologies how to reach it. So, for instance, the steel producing industry planning indicates the targets of the yearly steel production and defines the product mix by shape like flat products, sections,bars, etc, but the type and structure of steel is mostly neglected. In promoting this category of planning by stressing the modern development of steel and alloys with higher performances, being the subject of a more sophisticated technology, the research institute has a very efficient method to convince the management to include the R&D as a vital part of their planning.

The second stage of research activity is the actual research process. Depending on the type of research project it involves a broad variety of methods to be carried out. Metallurgical research is mostly concerned with multidisciplinary projects requiring the organization of the more complex working teams. Moreover, the accomplishment of a greater part of project require experimentation in more stages like laboratory-, pilot-plant and industrial experimentation. It proved very favourable to constitute the working teams not only of different experts belonging to the Institute, but also through engagement of engineers and technologists from the industry, university, etc. as part time collaborators. The mode of work of such teams is rather complecx but can be outlined roughly by demonstrating an example, for instance the investigation of possibility to produce a self fluxing sinter based on a particular mix of domestic iron ores. The investigation involves pilot plant experiments varying the basic technological parameters in order to obtain optimum of basicity and strenght, monitored by extensive laboratory work testing the chemical, mineralogical and reducibility properties of obtained sinter and, finally the verification of obtained

recommandations on an industrial sinter plant. The set up of basic research concept as well as plannin of experiments i accomplished by the full team under the leadership of project manager. The same applies for discussion of obtained results. But the accomplishment of experiments as such is made on laboratory and pilot-plant scale by Institute's staff, and in the execution of industrial experiments the industrial people, engaged as collaborator, can be very useful. They help with their practical experiences making the investigation more pragmatic and suitable to be accepted in regular use. The participation of industrial experts in mixed working teams in establishing the research programme, the opportunity to exchange ideas with the scientists and university people proved to be very useful to promote the cooperation, to facilitate the innovative performance arising from research results, and finally, to promote the interest of management for R&D services as a whole.

In competing for the confidence from the part of industrial management, the research institute is obliged to follow strictly the wishes of the customer and the stipulations of the contract. If, by some reasons, the research institute is not able to accomplish the project on time, it is necessary to inform the customer in a proper time giving the causes of delay and avoiding any unnecessary mistakes. The same applies for the case where research program should be extended due to the experiences and results gained in the course of research. Finaly, the research reports are to be written clearly, avoiding unnecessary texts which can be found in the corresponding textbooks and papers, but concentrating on the pragmatic substance and recommandations how to make use of obtained results. One has to bear in mind that the quality and mode of communication of research results in very important element for the acceptance of new technologies and operations

in regular use. Moreover, a spirit of cooperation and readiness of researchers to assist in implementation of the recommandations o convert them into practical results in an essential factor to eliminate the resistance of industrials against changes caused by conservativ attitudes or any other psychological factors.

In some cases it is recommanded to make the costs of research as low as possible but to stipulate in the contract a certain share in benefit obtained through the use of research results. This particularly applies for the cases of reluctance to solve the production problems through R&D services, but development of methods how to follow - up the use of results as well as how to checque up the benefits obtained is necessary in such cases.

There is a considerable experience gained so far in estabilishing a cooperation on international level. Some exemples will be given to indicate this sort of activity. The participation of the Institute in the research work of international institutes will be demonstrated on the case of cooperation within the European Community for Coal and Steel being located in Bruxelles. A considerable importance in the research activity of the Community is given to the problem of teaming and solidification od steel. The participants in this research are the leading metallurgical research institutes of the Western Europe like: Max Planck Institut für Eisenforschung in Düsseldorf, Universities in Aachen and Clausthal, Centre National the Recherches metallurgique in Belgium, IRSID in France, Research Centers of British Steel Corporation and other. Every organization participates in this research having a particular project in this field. The representatives of the participants constitute an"Executive Committee for Teaming and Solidification" being a forum to discuss and approve the research projects, to monitor the progress of work and to discuss the obtained results. The sessions of

the committee are held two times in a year and corresponding reports are to be prepared and distributed in advance. Institute "Hasan Brkić" participates in this Committee with its research project on investigation of the influence of ladle refractories and ladle metallurgy on the occurence and properties of non-metallic inclusions in steel ingots for haevy forgings. A research programme including investigation of 38 steel ingots from 20 to 80 t weight, prepared through extensive experimentation on industrial scale, is developed and is partly financed by the European Community. The results having been discussed by highly competent members of the Committee proved to be satisfactory. But the basic benefit of this participation is the opportunity to exchange ideas and experience, to learn the newest research trends in the most competent organizations in developed countries and to establish the contacts with their scientists. This research project, having a multidisciplinary character, gives excellent opportunity for gaining the knowledge in deoxydation theory and practice, modern methods in physical metallurgy of steel ingots etc.

Beyond this, the Institute is involved in some research projects on bilateral basis with the similar organizations in industrialized and developing countries. The cooperative research on a project concerning the investigation of the iron ore from Ljubija deposit in Yugoslavia might illustrate this sort of activity. The project was performed in cooperation with the research laboratories of the german company Gutchoffnungshütte. The iron ores of Ljubija deposit, being hydrocarbonates, have an average iron content of 51 % in run of mine state. According to the programm, the suitability of these ores for use in direct processes had to be investigated. A research programme comprising the investigation on possibilities of beneficiation to high grade concentrates with the subsequent testing of behaviour during the direct reduction treatment, as well as testing the quality of the sponge iron obtained, has been set up

in a cooperative action. The experimental work has been divided in two parts the first part comprising sampling and development of beneficiation technology, and the second part the direct reduction experiments. The Institute "Hasan Brkić" implemented the first part and produced the pellets with 65 % Fe, and the G-H-I Laboratories produced the sponge by processing the pellets procured by Institute "Hasan Brkić". After mutual discussion of results a joint report was prepared under the title of both organizations. A similar method applies to some research projects concerning the development of high strenght microalloyed steels for steel structures, performed in cooperation with the "Central Scientific Research Institute for Steel Metallurgy (CNIČERMET) in Moscaw. A joint paper was prepared and published in the Russian journal "STAL", indicating the names of the authors of the two organizations.

As a good illustration of cooperation with the similar organizations in developing countries might be the joint research project with the "MARMARA RESEARCH INSTITUTE" in Turkey, which is now under implementation, as well as a project with the "CENTRAL METALLURGICAL RESEARCH AND DEVELOPMENT INSTITUTE" in Egypt, being in the course of preparation. The cooperation with the Marmara Institute refers to the project comprising the elaboration of quality control systhem in Iron & Steel Works "KARABÜK" in Turkey. This project is financed jointly by UNIDO and by turkish steel industry, the UNIDO share covering the costs of Institute "HASAN BRKIĆ", and the turkish share covering the costs of Marmara Institute. Both institutes set up jointly the program of action. The work started in the field by joint action of both institutes sending to Karabük a group of 20 selected experts, 10 of them belonging to each institute. This action lasted 15 days in which time the experts collected all the data on production technology needed for the establishment of an adequate quality control

systaem. The further work will be continued independently each partner having precisely defined part of job in his own responsibility. The joint meetings are foreseen to discuss the results obtained as well as to prepare a program of actions for the next period. The Institute "Hasan Brkić" is obliged to prepare a report for his part of research to UNIDO, as well as for Marmara, and the Marmara Institute will incorporate this report in its overall report being the subject of contract with Karabük as the final user. The experiences gained up to now are very stimulating because the partners enjoyed the cooperative action ant one had not any difficulties to establish a coherent working team.

The research project for Egypt being now under preparation deals with the improvment of quality of the ingot moulds being a major problem of the egyptian steel industry. The project is intended to be a cooperative action organized on a bilateral principle. A joint team of experts will visit the foundries being the ingot moulds producer as well as the steel melting shops, being the ingot moulds consumers in Egypt and will jontly set up of program of research. Both partners will in the subsequent s ge perform their part of research inde endently and periodical meetings are fores en to discuss the results as well as to exchange the ideas. A set of papers is to be prepared and a joint meeting being the forum for the presentation and evaluation of results is foreseen to be held in Egypt in the final stage.

One of the utmost important cooperation which proved to be cathalytic to establish many international contracts and to develop various modes of cooperative research is with UNIDO having started almost 10 years ago. In the first stage UNIDO gave the assistance supporting the implementation of the projects on improvement of country's metallurgy by providing the fellowships, experts and equipment for the strenghtening the capabilities of the institute, enabling them to solve a number of problems facing the metallurgy of the country.

Some of the activities of international experts being involved in this programme proved to be very stimulating in mastering some sophisticated methods and techniques like X-ray fluorescense analysis, electron microscopy, beneficiation of the iron ores etc. In the later stage UNIDO appointed some of the staff-members of the Institute for the assignement on the improvement of metallurgical research in Egypt, Turkey as well as gave the opportunity to establish the contacts with the metallurgical research people in Jamshedpur (India).

The activity of the Institute's staff members in Egypt and Turkey as UNIDO consultants proved to be catalytic for a broader cooperation resulting in cooperativ research projects mentioned above. There are many new ideas and initiatives in the present stage for new projects as well as for new modes of activities So, for instance, the Marmara Research Institute in Turkey is in full course, to establish closer relations with the turkish industry. In the case of insufficiency of adequate capabilities for solving some particular problems arising through this activity, the Marmara Institute engages the Institute "Hasan Brkić" as his subcontractor helping him with its experience and capabilities. The same applies for the Central Metallurgical Research and Development Institute in Cairo.

In the present situation Institute "Hasan Brkić" can provide:

- Research services on laboratory, pilot plant and industrial scale in the field of steel metallurgy, particularly on ore beneficiation, steels and alloys development, physical metallurgy of steel,

- Consultancy services through preparation of feasibility studies for the development of steel industry as well as for the modernization of the existing steel industry, impro-

ment of technology and organization of quality control,

- Consultancy services in establishing the cooperation between research institutes and metallurgical industries as well as in the organization of the R&D services,
- Training fecilities for research people in sophisticated laboratory and pilot plant techniques in the field of steel metallurgical research, with a particular reference to ore beneficiation, steel melting and processing, chemical and physical testing methods, the use of computer in metallurgy,
- Training opportunities in some selected metallurgical industries in Yugoslavia under the supervision of Institute's research- and expert staff.

The presentation of development and experiences gained in the 15 years of activity of the Institute illustrates its present orientation to be in full course to establish a cooperation on an international level. The assistance of UNIDO proved to play an outstanding role in catalysing the international contacts and helping to the Institute to develop its present capabilities.

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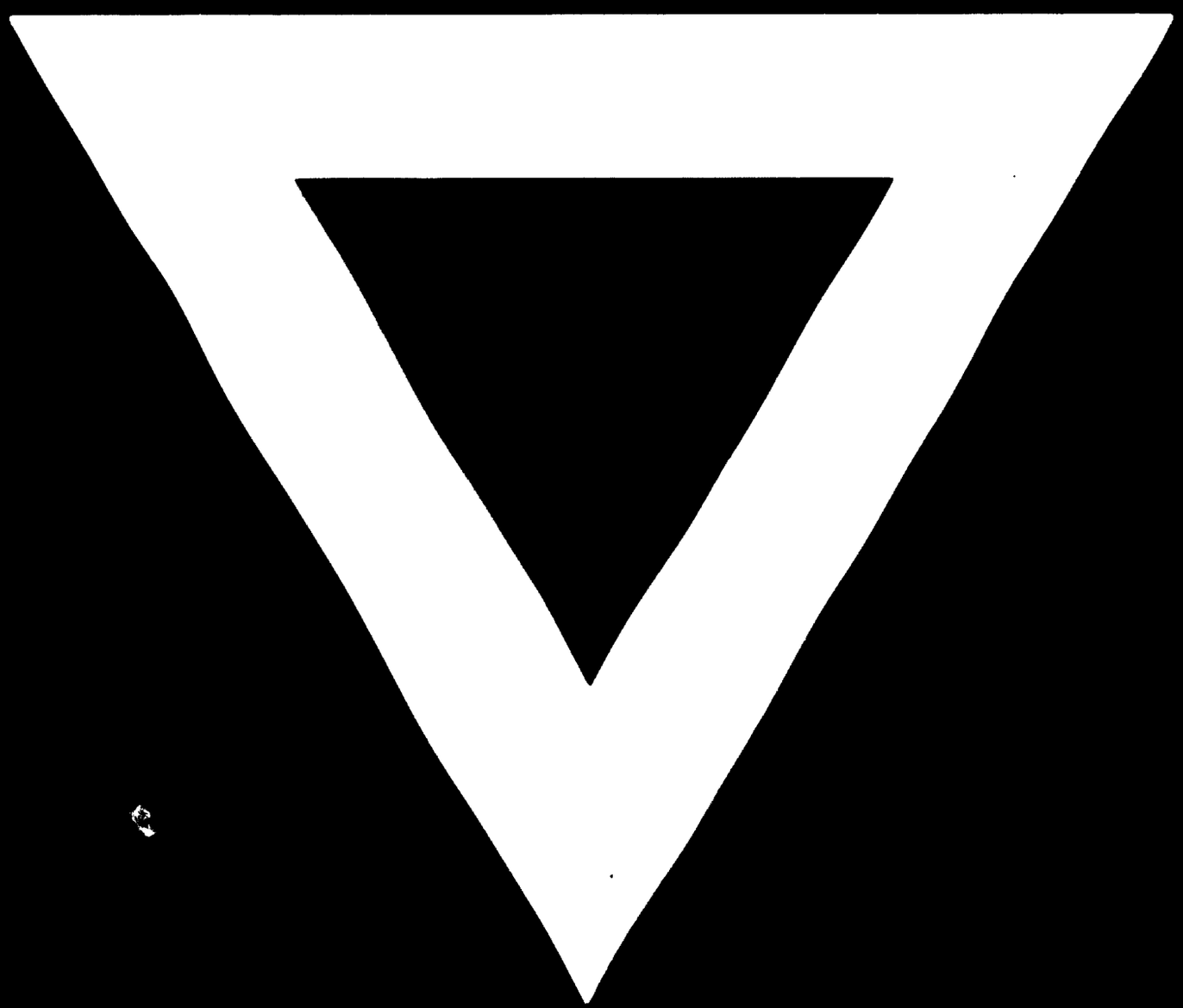

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