

Welding Education at WRI, Tiruchirapalli

By S. K. SRINIVASAN* and B. PULLAT*

1.0 Indian Industry—an overview

Many of the remarkable economic victories the world over have been achieved as a result of the great strides made in science and technology. The basic objective set forth in the sixth Five Year Plan indicates India's desire to achieve self-reliance in technology. Highest priorities have been given to the development of core industries like power, cement, steel and petro-chemicals.

The ambitious development programmes during the sixth Five Year Plan period of Government of India provide for a growth of about 75% over the existing power generation capacity and for a simultaneous rise in the output of other core sectors such as steel, coal, cement and petroleum products. This indicates the country's attempts at rapid industrialisation. Both technological expertise and skilled man power have to be built up continuously to meet the ever increasing demands of these industries.

2.0 Welding and Welding Education in Industry

2.1 Like many other trades, welding was also an under developed profession. Various industries, until lately, tackled their welding problems all by themselves,

*The authors are with the Welding Research Institute, Tiruchirapalli-620 041. This Paper was presented at the conference of various Welding Research Institutes, organised by Japan Welding Society at Osaka in October, 1980.

without much of external help whatsoever. Some industries have gained the know-how of sophisticated processes through collaborations but wider adoption of these processes was difficult among the industries owing to the constraints in dissemination. The training in welding was more of a product oriented necessity, as compared to the present day need of process oriented systematic learning leading to certificates and qualifications. Every individual firm tackled the welding problems in their own way and very little efforts were made even in the 1960s to consolidate the welding knowledge and share it. In the areas of high pressure piping, process piping, pressure vessels manufacture, Nuclear fabrication, ship-building, machine parts production and so on, the systems employed with regard to welding technology were much below satisfactory levels even in the 70s.

2.2 The Engineering colleges in India turn out a large number of graduates in various disciplines of engineering viz., Mechanical, Electrical, Metallurgical, Civil and many other branches every year. It is estimated that nearly 27,000 engineering graduates come out annually from these institutions. Nevertheless, even today, welding remains only as an optional subject or a chapter of metallurgy in the undergraduate curriculae of many Indian Universities. Some leading technological institutions in the country have been offering post-graduate courses in welding and metal joining sciences from as early as 1960. Very many engineering graduates, at the

same time, after having put in considerable experience in welding fabrication become specialists in metal joining and gather due recognition as welding engineers.

Around 50,000 diploma holders, pass out annually from different polytechnics in the country. It would normally take two to three years before these fresh technicians become conversant with the actual practices in the industries. Around 150 Industrial Training Institutes, set up in various parts of the country, provide basic skills to around 3,000 welders per annum. Many large companies are taking these welders and offering them one year Apprenticeship (A Government of India Scheme) Training. There are a couple of private training centres where advanced welding training is also offered. The Indian Institute of Welding, a national body, is also helping the industries for quite a few years, by organising refresher courses in welding for engineers, supervisors and welders.

2.3 One of the main objectives of the Welding Research Institute (WRI) which came into being in the year 1975 in Tiruchirapalli, was to disseminate whatever welding knowledge has accrued from the research conducted on various welding processes, to the industry, from all sources in the world through the various published welding journals, documents of International Institute of welding, compiled papers from welding societies and conferences, etc.

2.3.1 WRI felt the need of a centre for systematic learning in welding. This centre, called 'The School of Welding' is now engaged in moulding personnel at various levels into welding professionals, capable of viewing the contemporary welding techniques in a wider and clearer perspective, and confident of adopting newer welding techniques when such need arises in their firms. A comprehensive scheme of welding education in the graduate level was therefore felt by WRI as one of the prime requirements of the industry. Being a major activity of a leading research organisation, the School of Welding had the access to most of the modern welding machines, sophisticated testing facilities, faculty consisting of highly qualified research engineers and an exhaustive library and resource centre. An eight weeks course for Engineers, conducted at WRI covers (Refer Annexure 1) all aspects of welding : processes power sources, consumables, weld design, metallurgy, testing, weld economy and safety. The engineers have to take up specific project works pertaining to the particular problems existing in their respective industries. A report on the same is submitted at the end of the course. For 60 percent of the total hours, advanced welding theory is taught. During the rest 40 percent

of the total hours, the engineers undergo practical training in welding processes, maintenance aspects and destructive and non-destructive inspection. An industrial tour is also arranged to the neighbouring representative industries. Normally mechanical, electrical and metallurgical engineers who are already working in the field of welding are sponsored to the courses by various firms.

2.3.2 WRI has recently started a two year post graduate course in welding engineering, conducted in collaboration with the Regional Engineering College at Tiruchirapalli. The syllabus for this programme is given in Annexure-1. The Welding Research Institute is adequately equipped for the conduct of this post-graduate level programme.

2.3.3 Welding technicians who work in the supervisory cadre were either highly experienced welders-turned-chargemen or fresh diploma holders belonging to the three branches of engineering viz. mechanical, electrical and metallurgical. The present trend in the industries is to take more number of technically qualified personnel for supervising welding fabrication and erection. It has become an absolute necessity to impart sound theoretical inputs to these supervisors to upgrade the present technological levels and to introduce in the future more and more advanced welding techniques.

The supervisors are trained at the School of Welding for a period of 4 weeks. A balanced syllabus is formulated for this course taking into consideration the lower theoretical level of the experienced supervisors and the initial skill levels of the fresh diploma holders. 60 percent of the total hours estimated for a Welding Supervisors' programme goes for practical learning. Theoretical lectures constitute the rest 40 percent.

The syllabi (Refer Annexure 1) cover most of the application aspects of welding processes, the description of power sources and their maintenance, welding productivity, safety, basic metallurgy, testing of welds and design of weldments. Distortion and common weld defects are also dealt with in depth, enumerating the remedial measures for each type of defect. The Supervisors' Course participants are required to choose a topic in their area of interest and are asked to deliver a lecture on the same towards the end of their four weeks' programme. Industrial visits to neighbouring organisations are also included. The supervisors who have undergone this programme would have essentially acquired enough knowledge and skills, reinforcing their confidence, both in promoting the contemporary techniques and in adopting a completely new method of welding in the future.

2.3.4 The Welding Research Institute in collaboration with the local Government Polytechnic has been conducting a 'Post Diploma Course in Welding Technology' for the past five years. Diploma holders in Mechanical, Electrical and Metallurgical branches are thus given an opportunity to begin their career as qualified welding technicians by undergoing this one year course. The syllabus for this course is given in Annexure-1.

2.3.5 The welders in India are basically of two groups. The aged welders whose experience in the welding field counts from as far back as the 1950s and the others the products of the 150 Industrial Training Institutes (ITI) established throughout the country, after independence. The ITIs offer one year courses in various engineering trades. Entries to these courses are after 8 years of general schooling. There is also an Advanced Training Institute, where further skill development programmes in the trades are organised. Passouts from the above institutions generally undergo the one year 'Act Apprentice Training' with bigger concerns, before they are absorbed into the production lines. Largely, ITI qualified welders with 5 to 10 years of experience are sponsored to the Welding Research Institute for further training leading to certification as per various codes.

ANNEXURE—1

BROAD SYLLABI OF THE PROFESSIONAL AND ACADEMIC COURSES CONDUCTED BY THE WELDING RESEARCH INSTITUTE

1. Welding Engineer's Course (conducted at WRI) Duration : 8 weeks

- 1.1 Arc Physics
- 1.2 Welding Power Sources
- 1.3 Flux Coated Arc Welding
- 1.4 Flux shielded Arc Welding
- 1.5 Gas shielded Arc Welding
- 1.6 Resistance Welding
- 1.7 Under-water Welding
- 1.8 Advanced Welding Processes
- 1.9 Weld design and Economy
- 1.10 Safety
- 1.11 General Metallurgy
- 1.12 Welding Metallurgy
- 1.13 Defects, Testing and Acceptance of welds

2. Welding Supervisor's Course (conducted at WRI) Duration : 4 Weeks

- 2.1 Processes and Power Sources
- 2.2 Consumables
- 2.3 Accessories
- 2.4 Other Processes
- 2.5 Weld Design and Economy
- 2.6 Safety
- 2.7 Basic Welding Metallurgy
- 2.8 Weld Defects and Quality Control

3. Welder's Course (conducted at WRI) Duration : Mutually Decided

(All Subjects from Part B and any one or a Combination of Subjects From Part A)

- 3.1 PART A :
 - 3.1.1 Manual Metal Arc Welding
 - 3.1.2 TIG Welding
 - 3.1.3 MIG Welding
 - 3.1.4 Submerged Arc Welding
 - 3.1.5 Oxy-Acetylene Gas Welding & Cutting
- 3.2 PART B:
 - 3.2.1 Elementary Electricals
 - 3.2.2 Elementary Metallurgy
 - 3.2.3 Weld defects, Detection and Acceptance Criteria
 - 3.2.4 Weld Drawings & Edge preparations

4. Post Diploma Course in Welding (conducted at the Government Polytechnic—Tiruchirapalli) First semester (June to October)

- 4.1 Welding Technology I
- 4.2 Welding Technology II
- 4.3 Welding Technology III
- 4.4 Weld Design and Drawing
- 4.5 Arc Welding Practicals

Second Semester (November to March)

- 4.6 Welding Metallurgy
- 4.7 Welding Economy

- 4.8 Welding Applications and Testing
 - 4.9 Weld Design and Drawing II
 - 4.10 Oxy-Acetylene Welding
 - 4.11 Welding Technology IV
 - 4.12 Non-Destructive Testing
- 5. Post Graduate Course in Welding (Conducted at the Regional Engineering College—Tiruchirapalli) First Semester (June to October)**

- 5.1 Material Science
- 5.2 Electrical theory of welding equipments
- 5.3 Conventional Welding processes
- 5.4 Brazing, Soldering, Cutting & Surfacing
- 5.5 Computer programming

Second Semester (November to March)

- 5.6 Welding Metallurgy I
- 5.7 Advanced Welding Processes
- 5.8 Weld Design
- 5.9 Basic Metal Forming and Casting
- 5.10 Numerical Analysis

Third Semester (June to October)

- 5.11 Welding Metallurgy II
- 5.12 Testing Inspection and Quality Control
- 5.13 Economics of Welding Processes
- 5.14 Organizational Management
- 5.15 Welding Application

Fourth Semester (November to March)

- 5.16 Project Work—Lectures and Group Discussions.

Due commercial recognition and the merit of being a research organisation enabled WRI to become a useful learning and certification centre. Welding of various materials employing different welding processes conforming to more than one code is a routine feature at the Institute. Also a good liaison with the external inspection agencies is easily possible at a centralised place as this. Time, money and efforts for training and

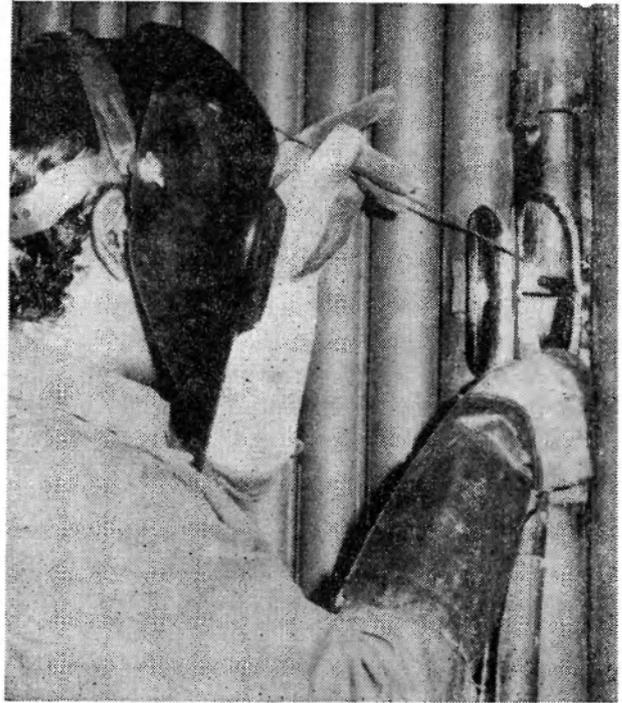


Fig. 1. Site Simulation Exercise—water wall Panel of a Power Boiler.

certification can thus be brought down. Above all, the learning in WRI being very systematic, the trainee after completion of his course leaves with a comprehensive knowledge of his present job and also with an aptitude to learn the welding processes of the future.

The type of programmes available for welders in WRI is (i) organisation based training and (ii) training for qualification as per approved codes of practice. Welders are trained from six to twelve weeks, depending upon their initial skill levels, nature of the jobs and the stringency of the relevant codes. The various codes to which training is given in the School of Welding are Indian Boiler Regulations, ASME IX, DIN 8560, I.S. and B.S. Out of the total hours estimated for a welder, about 20 percent goes to theoretical lectures, films, other audio-visual programmes and industrial tours. For the rest 80 percent of the total hours, practicals are arranged in the concerned welding processes, materials and positions. Site simulation exercises (Figs. 1 & 2) are also given to the welders in addition to their qualification joints. The theoretical portion (Refer Annexure 1) consists of the basics of the concerned welding processes, basic electricals and metallurgy, maintenance, safety and drawing sessions. Daily and weekly performance checks are done with the help of appropriate formats (Figs 4 & 5). The instructor to trainee ratio

FIG. 4. DAILY WORK-DIARY FOR WELDERS

WRI : SW : 004		SCHOOL OF WELDING WELDING RESEARCH INSTITUTE	
WORK DIARY OF	MR.	ROLL NO.	
1. PROCESS	MMAW	TIG	MIG
	SAW	PLASMA	GAS
	DATE		
2. JOB	SHAPE	THICKNESS	NO OF JOINTS
	PPE		
	TBE		
	PLT		
	MATL	POSITION	BUTT/FILLET
	VEE ANGLE	ROOT GAP	NO OF PASSES
	PRE HEAT INT PAS TEMP	SHOULDER	PRE HEAT INT PAS TEMP
3. FILLER METAL/ ELECTRODE	NAME OF FILLER/ ELECTRODE	SPEC	DIA(mm)
	ROOT PASS		
	INT. MDTE. PASSES		
	FINISH PASS		
4. THEORY LECTURE SUBJECT	HOURS	TOTALS:	
			REMARKS OF INSTRUCTOR:
			INITIALS:

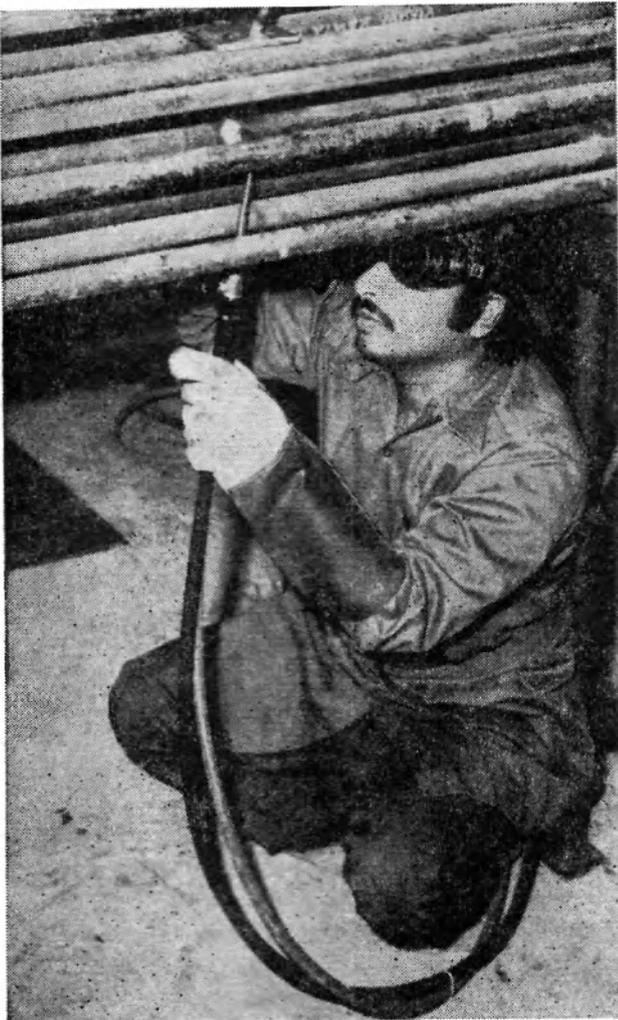


Fig. 2. Site Simulation Exercise—Economiser Tube Repair with the help of a Mirror.

being 1:5 the amount of attention available to one trainee is very high. Instructors are highly experienced and also well qualified to take theoretical lectures.

2.3.6 The Basic Courses discussed above should be followed up by refresher courses from time to time for the continued benefit of the industry. The engineers and supervisors from the welding industry are frequently drawn for a series of appropriate short term courses conducted by the School of Welding on various upto date welding topics. The short term courses last for three to five days. Eminent figures from the welding industrial scene are invited to speak to the short term course participants apart from WRI experts. The responses to these mini courses are exceedingly encouraging mainly owing to the fact that these courses create an opportunity for the annual evaluation and

appreciation of a particular topic by way of concerned people assembling together every year for such courses. Titles such as—Weldability of Steels, Ultrasonic Testing of welds, Pipe Welding, Design of welds, Distortion, Quality Assurance in Welding, Flux Shielded Welding Processes, Gas Shielded Welding Processes, Welding Procedure and Performance Qualifications, Maintenance Welding, Surfacing, Dissimilar metals welding, Power Sources for Welding, Fracture Mechanics of Welded components, Welding of Aluminium and its Alloys were covered under the short term courses conducted during the year 1979-80.

2.3.7 A majority of the firms need training programmes to be conducted in their yards so as to cover a large number of their executives, supervisors and workers. The 'Package Programmes' organised by the Welding Research Institute were to satisfy this requirement. Standardised teaching materials and other optimizations in course materials and administrative systems enable these programmes to be conducted throughout the country in an efficient manner. Package programmes are designed to the particular need of the concerned firm and they are normally planned for a duration of 1 to 3 days.

2.3.8 Extensive use of audio-visual aids such as slides, video films and transparencies covering various welding topics make the WRI training programmes very effective. Films on important welding processes are also shown to the trainees. The skill simulators for arc welding training will be very soon introduced in the practical sessions. Simulators help to reduce the training expenses and also impart a higher degree of self-confidence to the trainees. The information and publication department of the Institute is now busy making slide albums on separate lecture topics. These albums are mainly for the benefit of Instructor Trainees of various training centres in India.

3.0 Conclusion

The Welding Research Institute after its inception has made reasonable progress in the field of welding education in India. A good response from the industries has enabled the Institute, to a large extent, to help disseminate the welding knowledge among the personnel involved in welding and fabrication. It is hoped that through these trained personnel, the newer trends in the technological front that are taking shape in the field of welding can be fruitfully introduced in the industries.