Much of the consolidated knowledge now applied in the design and fabrication of nuclear fuel was obtained between the mid-1960s and the mid-1970s, with the contribution of relevant institutions and public companies, through research programs aimed at studying the nuclear, mechanical and thermal-hydraulic behavior of nuclear fuel in the core.¹

The first agreement for international cooperation between Europe and the United States in the development of Nuclear Power Plants (NPP) was signed on May 29, 1958 in Brussels when the US government and Euratom agreed on a memorandum of understanding to develop a Joint Nuclear Power Program. The main aim of this program was to build, in the six Euratom countries, nuclear power plants totaling 1,000 MWe of proven light water reactor technology, a technology in which the United States was at the forefront. The total cost of the program was estimated at 350 million dollars, of which the American government was ready to provide Euratom with 135 million. Special arrangements concerned the fuel cycle, including the burden of reprocessing irradiated fuel, which the US government declared itself willing to do in the United States. The American government and Euratom also intended to promote a joint program of research and development to be carried out both in the United States and in Europe on the types of reactors to be built, focusing especially on nuclear fuel. To this end, both parties agreed to allocate 50 million dollars for the first five years.

However, although the US government wished to export light-water reactor technology to Europe, the Joint Nuclear Power Program was scarcely implemented. At that time, no light-water reactor had been put into operation (in the United States the first NPPs Dresden and Yankee Rowe became critical in 1959 and in 1960 respectively), while France and England were engaged in the development of gas-graphite reactors.

¹ In those years, there was a US Atomic Energy Commission-Euratom operational cooperation agreement, and many public companies, such as British Nuclear Fuels Ltd (BNFL), Electricité de France (EDF), and the Ente Nazionale per l’Energia Elettrica (ENEL), participated in these activities.
Only Italy and Germany chose to build light-water reactors of the first generation, in Garigliano (a boiling water reactor - BWR), in Trino Vercellese (a pressurized water reactor - PWR) and in Gundremmingen (a BWR), which entered into operation respectively in 1964, 1965 and 1966.

It should be noted that in those years nuclear technology was in its “pioneering” stage, and the development of NPPs proceeded slowly. This meant that changes were often introduced in the engineering aspects and the data management, in order to improve the performance and reliability of the systems. The exchange of knowledge between European and American nuclear utilities was thus an important factor in the improvement of nuclear technology. However, there were significant differences in the approach to the design, construction, operation and safety of nuclear installations, which made it difficult to compare the different experiences. As a result, it became necessary to adopt a comprehensive approach to these problems, in order to provide a common reference for evaluating the reliability of the plants, which depends on a set of complex interdisciplinary processes that must be kept under control during all the steps involved in the building of a NPP.

The answer to these needs was the development of Quality Assurance, a system of rules and principles that was not limited to the control and testing of the final product, but allowed to intervene at every stage of the process, from the design to the operational phase, for each system and component involved in the NPP.

The United States was the first country to define a quality system in the nuclear sector based on a shared set of criteria and rules, with the publication by the Atomic Energy Commission (AEC) of Federal Code 10 CFR 50 Appendix B (Quality Assurance Criteria for Nuclear Power Plants), issued in 1970.

This document establishes eighteen basic requirements for the design, construction, manufacture and operation of structures, systems and components related to the safety of NPPs. In order to standardize the activities of nuclear facilities in the implementation of 10 CFR 50 App B, several other documents were developed such as ASME NQA-1 (Quality Assurance Requirements for Nuclear Facility Applications) and the series ANSI N 45.2 (Quality Assurance Program Requirements for Nuclear Facilities). The Nuclear Regulatory Commission (NRC), which replaced the AEC, approved both documents. In the wake of the publication of 10 CFR 50 App B and following the target of standardization, several other standards were developed throughout the world, such as the German standards by the Deutsches Institut für Normung (DIN) and the Italians by the Ente Nazionale Italiano di Unificazione (UNI).

The Italian company Ente Nazionale per l’Energia Elettrica (ENEL) was among the first to adopt 10 CFR 50 App B and from the early 1970s began to develop its own quality system. This involved a strong commitment on the part of many technicians, given that the eighteen basic requirements of 10 CFR 50 App B described “what” needed to
be done, but not “how” to do it. In other words, in order to apply the principles of the Code, it was necessary to develop a set of procedures, technical specifications and standards needed to achieve the quality objectives, especially given that at the time ENEL was evaluating the project of the Caorso NPP.

In those years, I had completed my training on the job, working in nuclear plants and participating in the review of some projects of NPP systems. Therefore, I welcomed with enthusiasm the idea of specializing in the design and fabrication control of nuclear fuel. I served in this activity until 1987 when, after the Chernobyl disaster, I decided to make a moral objection.

**Nuclear Fuel: A Special Component**

Nuclear fuel is a key component of the NPP operation. Being made of fissile material, mainly uranium, it represents the source of energy without which it would be impossible to operate the NPP. At the same time, nuclear fuel is of particular importance in terms of safety, since it makes up the first containment of fission products that are retained inside by the fuel cladding. Therefore, nuclear fuel performance and reliability are of utmost importance for the safe operation of NPPs, and it is crucial to maintain fuel integrity in all operating conditions.

Fuel integrity and performance mainly depend on:

1) Design criteria and specifications.

   Nuclear fuel is designed to ensure that possible fuel damage does not result in the release of radioactive materials in excess of the limits prescribed by the Safety Authority. Evaluations are made in conjunction with the core nuclear characteristics, the core hydraulic characteristics and the plant equipment characteristics. These general criteria must be correctly translated into specifications, drawings and procedures.

2) Fabrication methods and procedures.

   All phases of the manufacturing process must be supported by documented instructions, procedures or drawings that have to include specific quantitative or qualitative acceptance criteria for each material, component, test and process to be carried out during manufacturing.

3) Operation procedures.

   Operating limits are established to ensure that the actual fuel operation is maintained within the fuel rod thermal-mechanical design bases. These operating limits define the maximum allowable fuel pellet operating power level as a function of fuel pellet exposure.
Nevertheless, since a limited number of fuel failures do take place, it is important to investigate the mechanisms of rupture that occur during operations, in order to improve manufacturing techniques and forms of control or, if necessary, change the design specifications.

From this point of view, another important tool used to improve nuclear fuel performance and reliability was the Post Irradiation Examination (PIE), a survey method widely adopted in the 1960s and 1970s, but abandoned since the 1990s because of its high costs. The techniques currently in use for the control of nuclear fuel failure are based on sipping tests. This method investigates the fission product release in a fixed volume of a circulating reactor cooling water and is commonly used as a way to monitor the integrity of spent fuel elements in wet storage, or to investigate fuel elements that are suspected to have failed during the course of operation. However, since sipping tests do not provide indications on the remote causes that led to the fuel failure, there is a significant uncertainty on fuel failure mechanism evaluation. According to International Atomic Energy Agency (IAEA) estimates, today ~ 25% of fuel failure causes in light-water reactors are unknown.

**Nuclear Fuel Fabrication and PIE**

From the point of view of manufacture, nuclear fuel presents a series of very special characteristics that are often underestimated. Unlike other key components, nuclear fuel is produced in large quantities but must comply with very strict criteria that other components do not require. Ultimately, nuclear fuel fabrication may be regarded as a mass production with extremely high quality standards. This large-scale production – millions of Fuel Rods (FR), thousands of Fuel Assemblies (FA) – requires an extremely rigorous and reliable control system, along with a set of consolidated manufacturing procedures. Controls and procedures are integrated in a quality system, which operates at all stages of manufacturing. In the industrial field, nuclear fuel design and fabrication represent the most complex implementation of Quality Assurance criteria definitions:

\[ \ldots \text{“quality assurance” comprises all those planned and systematic actions necessary to provide adequate confidence that a system, structure or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provides a means to control the quality of the material, structure component or system to predetermined requirements.} \]

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A good quality system must meet the following criteria:
– full compliance with design and engineering specifications,
– reliability on fabrication methods and procedures,
– complete traceability of processes,
– very high precision working (to comply with strict tolerances),
– accuracy in cleaning and handling,
– highly skilled operators,
– quality control effectiveness.

Normally, an entire core of a 1,000 MWe NPP consists of 157 FA (the PWR type) or 624 FA (the BWR type). This means that the total number of controls required during the first core nuclear fuel fabrication varies from 14,256,000 (BWR) to 15,205,000 (PWR). A detail of these typical controls is shown in Figure 1.

<table>
<thead>
<tr>
<th>Major components</th>
<th>Number of controls per component</th>
<th>Assembly cumulative controls (BWR) (8x8-2)</th>
<th>Assembly cumulative controls (PWR) (17x17-25)</th>
<th>Core total controls** (BWR) (624 FA) (38,688 FR)</th>
<th>Core total controls** (PWR) (157 FA) (41,448 FR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UO2 pellets</td>
<td>17x20***</td>
<td></td>
<td></td>
<td>14,256,000</td>
<td>15,205,000</td>
</tr>
<tr>
<td>Zr tubes</td>
<td>10</td>
<td>↓</td>
<td>↓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>End cups</td>
<td>4</td>
<td>&gt; 21,948</td>
<td>&gt; 93,456</td>
<td>93,456</td>
<td></td>
</tr>
<tr>
<td>Fuel rods</td>
<td>13</td>
<td></td>
<td></td>
<td>918,000</td>
<td></td>
</tr>
<tr>
<td>Spacer grids</td>
<td>6</td>
<td></td>
<td></td>
<td>9,035</td>
<td></td>
</tr>
<tr>
<td>Nozzles</td>
<td>3</td>
<td></td>
<td></td>
<td>900</td>
<td>3,400</td>
</tr>
<tr>
<td>Fuel assemblies</td>
<td>13</td>
<td>~ 900</td>
<td>~ 3,400</td>
<td>14,256,000</td>
<td>15,205,000</td>
</tr>
</tbody>
</table>

Figure 1. Nuclear fuel fabrication control amplitude*.

* Excluding controls on row materials performed by suppliers (UO2 powders; metal ingots, etc.).
** 1000 MWe.
*** 20 pellets per rod tested.
POST IRRADIATION EXAMINATION

The severe operating conditions of reactors cause many stresses to the nuclear fuel. The high temperatures reached with fission modify the structure of the uranium pellets that interact with the cladding and deform it. At the same time, the cladding is subjected to mechanical stresses and stress-corrosion caused by cooling water. The combination of these factors, especially during transient reactor power, can cause the failure of nuclear fuel and the release of fission products.

PIE helps determine the causes of these failures and provides information on the performance of the fuel in the core, such as:

1) correlations for the prediction of reactivity coefficients under various operating conditions,
2) evaluation of reactivity variation due to a pH variation in the primary coolant,
3) analysis of power density distributions,
4) analysis of the core flow redistribution.

PIEs are of two types: destructive and non-destructive. One of the main techniques for non-destructive testing involves exposing the irradiated fuel to γ- scanning (gamma-scanning) in order to determine the axial distribution of the radioactive fission products, and consequently of the burnup. The gamma-scanning method measures gamma activities of certain fission products that are proportional to the burnup. Problems associated with this method are migration of the fission products and gamma-ray attenuation through the relatively dense fuel material.

Destructive tests consist in extracting some fuel rods, cutting and submitting samples to radiographic and metallographic examination, and chemical and mechanical tests.

THE ITALIAN EXPERIENCE

The first Italian NPPs – located in Latina, Garigliano and Trino Vercellese – became critical between 1963 and 1964. The main contractors that supplied the first cores were respectively: British Nuclear Fuel Limited (BNFL), General Electric and Westinghouse. A few years later, some manufacturing activities started in Italy to supply ENEL’s nuclear fuel reload.

Initially the main components of fuel assemblies were imported and assembled in small factories such as Combustibili per reattori nucleari (Coren) and Combustibili nucleari (CN). Coren, owned by the firms Breda, Fiat and Westinghouse was based in Saluggia (near Turin) and provided nuclear fuel for the Trino Vercellese NPP; CN,

3 Referring to NPPs, Burnup is the integrated energy released from the fission of heavy nuclides initially present in fuel, and is expressed in Megawatt Days per Metric Ton Uranium Initial (MWD/MTU).
owned by the Azienda Generale Italiana Petrolì (AGIP) and BNFL, was based in Rotondella (near Matera) and provided nuclear fuel for the Latina NPP. KRT of Großwelzheim in Germany supplied the nuclear fuel used for the Garigliano NPP.

In 1976, just before the Caorso NPP started operating, the company Fabbricazioni Nucleari (FN) located in Bosco Marengo (near Alessandria) began producing fuel on an industrial scale. The company was owned by a joint venture between Ansaldo, AGIP and General Electric (GE), which was the nuclear fuel designer. FN’s fuel production started with the fabrication of Caorso’s first core, which was composed of 560 FA, whose components were all manufactured on site, including pellets, grids and end plugs. The top management of FN, the procedures it used, as well as some skilled personnel came from GE.

In 1976, the number of Italian nuclear fuel experts could be counted on the fingers of one hand, given that the tasks one had to face were very difficult and delicate. Upon starting my inspections at FN, I realized that, despite the fact that the firm had adopted the GE quality system, the production standards it followed were not ideal. Its major shortcomings concerned the following aspects:

- operators’ qualifications and processes were below standard,
- wrong sampling procedures,
- fabrication methods were not in compliance with design specifications,
- management’s serious deficiencies and hostile relationship.

The kinds of wrong procedures that were applied in FN included the X-ray control on the end plugs welding and the control of the fuel rod bow. The end plugs welding ensures that during reactor operations the gaseous fission products are not released by the fuel rods. Therefore, checking the integrity of this welding is extremely important. FN applied a statistical control plan on end plugs welding with X-ray radiography, instead of 100% radiographic tests. This was even more detrimental to the nuclear fuel quality and safety, since the plant was in its first experience of production and manufacturing procedures were not sufficiently proven and reliable.

As far as the rods bow was concerned, the test implemented by FN consisted in rolling the rods on a 5 mm thick bench plate (made of stainless steel). Given that the design tolerance on the rod bow was of 1 mm for the entire length of the fuel rod (about 4 m), it was impossible to check this measurement with accuracy, because the bench plate was subjected to alterations in flatness due to the magnetic field, the temperature range and the roughness. In other words, the margin of error introduced by the bench plate was comparable to the value to be measured.

The correct procedure needs metrology test instruments like granite surface plates, having the following characteristics: 5 m length, 2 m wide, and 2 m high, weighing about 6 tons, flatness < 5 µm (0.0000005m). An example of a granite surface plate is shown in Figure 2 below.
Six months after production started, my inspection activities met with success, forcing GE to make an internal audit in which supervisors from the San José, California headquarters accepted most of my remarks. The measures that were taken concerned the following aspects:

- replacement of US management,
- change in fabrication methods and sampling procedures,
- change in the quality control plan and standard,
- production re-start.

In the following years, FN achieved good quality standards in nuclear fuel fabrication, attested by the low fuel defectiveness found in Italian NPPs (~ 1-1.5%).

As part of my audit work on nuclear fuel fabrication, I participated in research programs on the behavior of light-water reactors’ fuel in plants operating in Italy. In addition to the research programs carried out by the Comitato Nazionale per l’Energia
Nucleare (CNEN), ENEL developed a monitoring activity for the Garigliano NPP (BWR) and the Trino Vercellese NPP (PWR), two of the first power plants ever commissioned.

In the second half of the 1960s, several cooperation agreements between ENEL and Euratom led to a growth of these activities. In particular, the Euratom-ENEL 071-66-6 TEEI- RD and the Euratom-ENEL 092-66-6 TEEI contracts, which focused on PIE. The main objective of PIE was, as mentioned above, the measurement of the burn-up and the isotopic composition of selected fuel samples by means of gamma scanning techniques, in order to evaluate the accuracy of calculation methods applied. One of the aims of the Euratom-ENEL 071-66-6 TEEI-RD contract was the metallographic analysis of the UO2 pellets and the stainless steel cladding.

Initially, 52 fuel elements, 8 of which contained plutonium, were examined in the pool of the Garigliano NPP. Then 2 of these elements were transported to the ESSOR reactor in Ispra, in order to carry out the examination of 26 selected fuel rods, consisting of a complete gamma scan analysis and metallographic tests that were performed both at ADECO laboratories in Ispra and in Karlsruhe. As far as the Trino NPP was concerned, 4 fuel elements were subjected to gamma scanning, all of them transported at different times to the ESSOR reactor, where 49 fuel rods were extracted and examined with gamma scanning and metallographic tests at the Ispra and Karlsruhe laboratories. The irradiated assemblies were dismantled, some fuel rods and pellets were selected - representative of both the unperturbed and the perturbed reactor core region -, and cut from them after gamma scanning. The pellets were then dissolved and submitted to $\alpha$, $\gamma$ and mass spectrometry, in order to determine fission-product and heavy-element buildup, isotopic ratio and burnup.

It was the largest PIE program ever performed in Europe on power reactors and, as far as the PWRs of the first generation were concerned, the only one ever performed in the world. Unlike the fuel elements of the Garigliano NPP, those of the Trino NPP had not been designed to be disassembled; they were enclosed in a (perforated) metal casing and welded to the two terminals (upper and lower) to allow handling. In order to remove the fuel rods it was necessary to cut the casing just below the upper terminal (see Figure 3) without affecting the fuel rods: an operation that Westinghouse – which designed the plant – considered impractical, as it would have to be done underwater.

Nevertheless, a special team of ENEL – Centro Progettazioni Nucleari designed and built a structure of underwater cutting and containment, equipped with pneumatic cutters that could be operated manually outside the nuclear fuel pool, which made it possible to complete the operation.
Figure 3. Cutting device: movable slide, air-operated motor.
Figure 4. Cutting device: view of cut fuel element.
When I started working for ENEL, there were many technicians like me who believed that the use of nuclear energy would allow to achieve the objectives set out in the ENEL charter: “To assure, at minimum management cost, the availability of electrical energy sufficient in amount and price to the requirements of a balanced economic development of the country”. In other words, many of us believed that the development of nuclear energy was an opportunity to promote the country’s development, and were truly excited about our work.

It was only after the 1973 oil crisis that our attitude toward nuclear power changed. The price of oil skyrocketed and so did the orders of nuclear power plants that hitherto had not been economically competitive: the era of cheap energy was finally over. Then we understood we were facing an epochal restructuring of the global energy system, in which the role of nuclear energy would not be “to provide abundant electrical energy in the power-starved areas of the world” – as outlined in the Atoms for Peace program – but to increase the power of the most important energy companies and of the countries that controlled nuclear technology.
Therefore, along with some of my colleagues who shared my concerns about ENEL’s nuclear policies, I began an information campaign against the Italian government’s plan to build several NPPs, and denounced the links with the field of nuclear weapons that this technology brought with it.

In 1975, on behalf of the government, Minister of Industry Carlo Donat-Cattin presented the Piano Energetico Nazionale, which received support from the Comitato Interministeriale per la Programmazione Economica (CIPE). It was the first national energy plan to be approved by the Italian Parliament and was based almost exclusively on the construction of 20 NPPs totaling 20,000 Mw to be realized by 1985. During the same period ENEL was authorized to participate in a joint venture with EDF of France and RWE of Germany to build Fast Breeder Reactors (FBR), the first of which (Superphénix) was built in France at Creys-Malville.

For us – engineers working in the field – it was a colossal program that did not meet the needs of the moment, but was serving the interests of big energy companies that wanted to obtain contracts with ENEL. Our information campaign was based on the following issues:

- the nuclear program was oversized compared to the forecast of electricity demand. It was a 50 per cent increase in installed capacity over a period of ten years (in 1975 the total installed capacity was 40,000MW);
- ENEL had not provided the necessary funds for such an investment, so a considerable increase in electricity rates was inevitable, especially household rates;
- despite the increase in oil prices, the cost of nuclear KWh was not competitive with that obtained from conventional power plants. Moreover, the experience of the Caorso NPP (then under construction) indicated that the goal of building two nuclear power plants per year was unrealistic;
- the hydrographic and geological configuration of Italy (its seismicity), in addition to its population density, were not suitable for the construction of twenty nuclear power plants. This meant that all plants would be built on the coast, with a significant increase in costs and a penalty for tourist activities;
- the construction of twenty NPPs would have monopolized ENEL’s activities and those of manufacturing companies, and would have undermined the search for different technological solutions in the field of electricity generation. Although at the time it was perhaps premature to invest in renewable energy sources, other technologies were developing, such as those related to combined cycle gas turbine and the gasification of residues from oil refining of which Italy had large stocks;
- from the point of view of its economic and social effects, the nuclear program would create many inefficiencies. After an NPP was completed, employment lev-
els would be particularly low, compared to other industries with the same investment. Moreover, in large parts of the territory and along the coasts, agriculture and other activities carried out by local populations would be forbidden;

– last, but not least, building such a large number of nuclear power plants raised two major issues: first, the problem of radioactive waste disposal, which was completely ignored by the National Energy Plan; second, given the considerable quantities of plutonium to be derived from NPP operations and from the Superphénix fast breeder reactor, the connection between the civilian nuclear program and military strategies.

Given the presence of a strong lobby defending the interests of the oil companies against nuclear power, it was not easy for us to explain our position, since we could easily be considered supporters of the oil lobbies. It was equally difficult to communicate with local populations involved in discussing where NPPs should be built. These were composed primarily of ordinary people who asked us (technical experts) to be reassured about the risks of NPPs, while at the same time being attracted by the benefits they could reap if the plants were built. Given the technical expertise we had acquired working in the nuclear field, we did not initially consider the issue of safety as a priority. It was only after the Three Mile Island accident in 1979 that we had evidence of the dangers of these plants and of the entire nuclear cycle. Throughout this period, I continued to carry out my control activities on nuclear fuel, aware of the great delicacy of my work, while at the same time participating in the activities of the anti-nuclear movement, either in public meetings in Montalto di Castro (where two NPPs were to be built), or in conferences at the University of Rome.

These activities were accompanied by the publication of brochures on nuclear technology and on several experiences that were developing in Italy and in other European countries against nuclear power.4 The anti-nuclear movement, in fact, was perhaps the only transnational movement that affected Europe, and it was a spontaneous movement, not led by parties or large organizations. Most European parties and trade unions were in favor of nuclear power, and this made it more difficult to challenge this policy. Anti-nuclear supporters were often described as obscurantists, enemies of progress and science that wanted to return humanity to a primitive state. The first major event of the Italian anti-nuclear movement was held in Montalto di Castro on March 20, 1977 with the participation of thousands of people coming from various parts of the country. The land where the nuclear plant was to be built was symbolically occupied, and in the

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4 Crisi dell’energia e ristrutturazione (Roma: cyclostyled by Comitato Politico ENEL, 1973); Contro la truffa nucleare (Roma: cyclostyled by Comitato Politico ENEL, 1975); Le lotte antinucleari in Europa (Roma: cyclostyled by Comitato Politico ENEL–Comitati autonomi operai, 1977).
following months a unique form of protest emerged, the anti-nuclear organization of campsites. The movement promoted forms of communication with the local population and discussed with them the problems arising from the construction and operation of the NPP. After 1978, “anti-nuclear camping” was organized not only at Montalto di Castro, but also at Nova Siri (Matera), Cerano (Brindisi), and Brasimone (Pistoia), all placed involved in the building of NPPs.

Personally, I ended up in a paradoxical situation, which would be impossible today. On the one hand, ENEL’s leadership (which was aware of my anti-nuclear activities) wanted to fire me, or at least give me another assignment. On the other hand, my professional skills prevented ENEL from pursuing its goals, given that I had made a significant contribution to the development of its quality assurance, and had forced the powerful GE to review the Caorso nuclear fuel fabrication management in the Bosco Marengo facility, even receiving praise from GE. Nevertheless, for more than ten years, ENEL’s management blocked my career: it was the price I had to pay for my anti-nuclear activities.

This controversial behavior lasted until 1987 when, after the Chernobyl disaster, I opted for a moral objection, and wrote an official letter to ENEL, making my decision public. This is the letter I wrote to the Office Staff – ENEL Headquarters:

With this letter I submit a formal request to no longer be used on tasks relating to the design, construction or operation of a nuclear power plant. This decision (which I intend to make public) may possibly appear peremptory, but my professional and social life have reached a point where I find myself faced with choices that can no longer be postponed. For sixteen years now I have dealt with nuclear fuel and in all that time my job has been to control its manufacture: first for Garigliano and Latina, Trino and then Caorso, Cyrene and Alto Lazio. For this work, although quite unusual, I do not feel either a scientist or an expert: simply I know I am a technician who, like many of his colleagues, strives to accomplish a specialized task correctly. But as you know I am also an anti-nuclear activist that for many years has been fighting to change ENEL’s energy policy, hence the dilemma that accompanied my job. Now I need to strive for clarity toward myself and toward all those with whom in the past I shared work commitments or ideals of struggle. After all, clarity has always marked, although with conflicting positions, my relationship with ENEL, with which I intend to keep faith even in this difficult choice. I say difficult because if for years I have lived with this burden – acting as an anti-nuclear activist and working as a diligent nuclear expert – it is also because I thought I could put something more into my work that was not strictly contractual: my suspicion, my scruples (and why not, my passion) to work on a component so unequivocal as nuclear fuel. If all this is not enough anymore, it is because after Chernobyl I realized that contributing critically is still cooperating, giving credit to the paradox that nuclear accidents are technologically impossible,
but statistically probable; but above all it is to forget that the Chernobyl firefighters, accepting a horrible death, prevented an even more serious catastrophe. Even though rationally I am convinced that the “nuclear plague” – in some respects – is not worse than the chemical one; although I perceive that the cloud of Chernobyl is used to hide other threats to humanity, I do not mean to endorse anymore – even with my experience – technological choices that are more and more intrusive and oppressive; I will no longer succumb to the engineering cynicism that considers life a “non returnable empty”; I cannot accept the cultural respectability of some scientists who send their banal appeals to reason to the head of state. It’s a reason that I do not respect and do not know, because it is a reason that does not think, like the science of which it is the daughter.

Giorgio Ferrari Ruffino, February 1987

My letter was sent to ENEL as well as to several newspapers that were interested in the anti-nuclear movement. I must admit that I was upset by the complete lack of reactions to my position, in particular from the (mostly academic) and widely known experts in the field. I continued to work as a technician for ENEL, although I was dismissed from the nuclear sector - as I had officially requested – and was for several years marginalized from any relevant task. I was later employed in ENEL’s foreign activities until I reached retirement.

I never regretted my decision. I was lucky enough to live my “nuclear adventure” with great passion at a time of great industrial planning and research, and with the same passion I participated in the anti-nuclear movement.