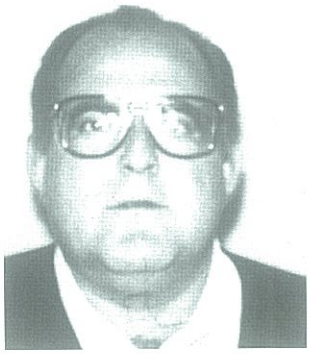
Jesús GONZALEZ FERNANDEZ received a Mining Engineering degree from the Madrid Polytechnical University. For several years, he worked in engineering companies in the hydraulic and nuclear areas, and in July, 1982, joined the Operating Department of C. Trillo as Operations Director. After collaborating in the startup of the Grohnde Nuclear Power Plant in West Germany, he was in charge of the startup of the nuclear systems and the First Hot Functional Test of C. Trillo I. Later, as Technical Services Director, he completed the Construction phase and is currently in charge of the areas of control and design modifications, as well as Training and Evaluation.



Alfonso SANJUAN CUESTA received a Telecommunications Engineering degree from the Madrid ETSIT and a degree in Nuclear Engineering from the JEN. He started working in the Trillo I Nuclear Power Plant in 1982, where he has participated in preparations for Plant operation and in testing and startup. As Operations Director, he has directed the nuclear tests, and since 1989 is Production Director of this plant.

FIRST YEAR OPERATING EXPERIENCES

J. GONZALEZ - A. SANJUAN

INTRODUCTION

Following completion of the plant's operating phase and after it had been turned over to the operating organization and the Provisional Operating Permit was granted by the "Consejo de Seguridad Nuclear" (Nuclear Safety Council) on 4-12-87, the following events occurred:

- First Fuel Loading 8/10-12-87.
- Hot Functional Test 3-12-87 - 5-2-88.
- First Prompt Criticality 14-5-88.
- Attainment of 30% rated power 15-5-88.
- First Synchronization with the mains 23-5-88.
- Attainment of 80% rated power 8-7-88.
- Attainment of 100% rated power 2-8-88.
- Commercial operation 6-8-88.

The Trillo Nuclear Power Plant operating organization performed all the above indicated jobs, and all operating experience gained is included in the nuclear test reports, in the design modifications made during this nuclear test period and in the plant operating manual and technical procedures. In addition, all those events that occur in a nuclear plant such as:

- Unscheduled trips
- Operating incidents
- Scheduled and unscheduled shutdowns
- Maintenance inspections and repairs

were taken into account, in order to analyze them and reach the pertinent conclusions so as to improve plant operation. The procedure followed and a description of the most important aspects are set forth below.

UNSCHEDULED TRIPS

In order to analyze the operating experience involved in Unscheduled Trips (DNP), the following procedures were prepared:

- Startup authorization after an unscheduled trip.
- Unscheduled trip report.
- Unscheduled trip evaluation.

F I *Unscheduled trips during the nuclear test phase*

NUMBER	DATE	DURATION (DAYS)	NUCLEAR POWER	CAUSES	SYSTEMS/ EQUIPMENT INVOLVED
1	31/5/88	0.4	30%	B	Condensate water & turbine bypass.
2	31/7/88	0.3	80%	E	Low DNB.
3	08/8/88	0.3	100%	D	Feedwater loss.

CAUSES: A. Equipment failure. B. Test with equipment failure. C. Test error. D. Human error. E. Spurious generation. F. Cause outside plant. O. Others.

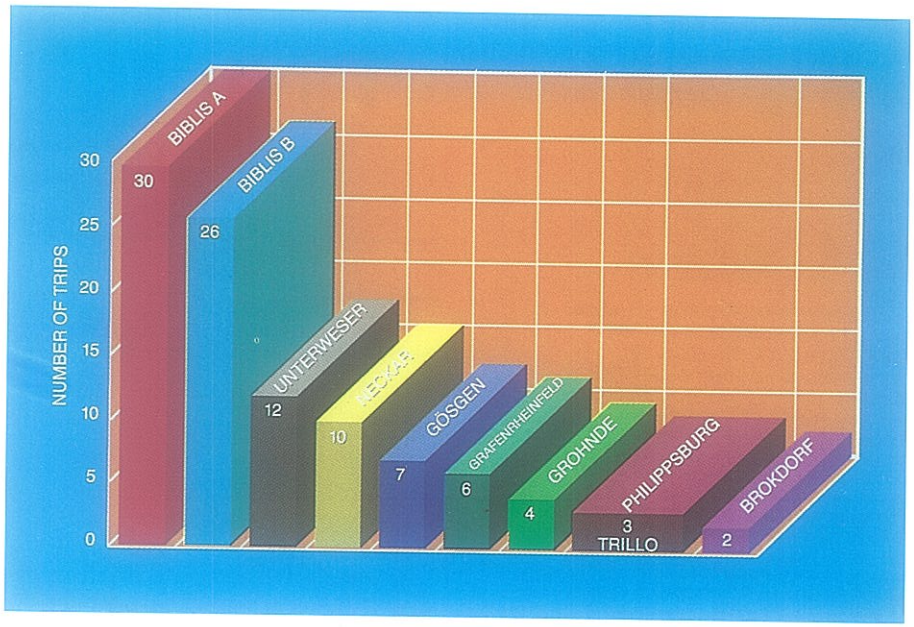
These procedures provide a systematic analysis methodology of unscheduled trips in order to:

— Identify the cause of the trip.
— Verify proper operation of the safety-related systems and equipment and those related to plant availability during the transient.
— Evaluate plant availability and safety in order to return to operation at rated power.
— Lastly, analyze the root cause and issue the suitable recommendations (changes in the operating manual, in design, in procedures, etc.).

Once the plant has been stabilized, the review process begins immediately. This consists of the following four phases:

Phase I: Investigation, analysis and initial appraisal.
Phase II: Startup authorization.
Phase III: Unscheduled trip report.
Phase IV: Evaluation and Final Report.

In phases I and II, both the written (alarms, registers, etc.) and spoken (service personnel) information is analyzed and appraised, in order to establish restartup of the plant.
In phases III and IV, the people that participated in phases I and II reach their conclusions and can schedule any relevant performance or recommendation.
During the nuclear test phase, three unscheduled trips occurred (see figure I). Figure II shows a comparison with DNP during the nuclear test phase in German plants.
Two DNP have occurred since the plant began commercial operation, as shown in figure II under Operating Incidents.
The first trip (24-8-88) was due to the loss of condenser well level regulation, which caused the condensate water pumps to trip and the subsequent loss of the feedwater pumps. This caused the level in the steam generators to drop, producing the reactor trip at 9 m.
The reason for loss of regulation was analyzed, which was a result of not resetting the hot well level signal after performing a condenser leak detection operation. The plant's behavior and the probable causes were analyzed, and the plant was started up again.
The operating manual was modified to include a check of level measurement and regulation disturbance during filling operations.
The second trip (25-4-89) was caused by the loss of two main pumps. A discharge of the Safeguard Diesel was being recovered and during the piston injection operation the diesel rolled over, causing an overintensity high enough to activate the corresponding protections of the Safeguard bar.
At that time, two of the main pumps' oil pumps were being supplied by this bar.
The trip causes and the plant's behavior

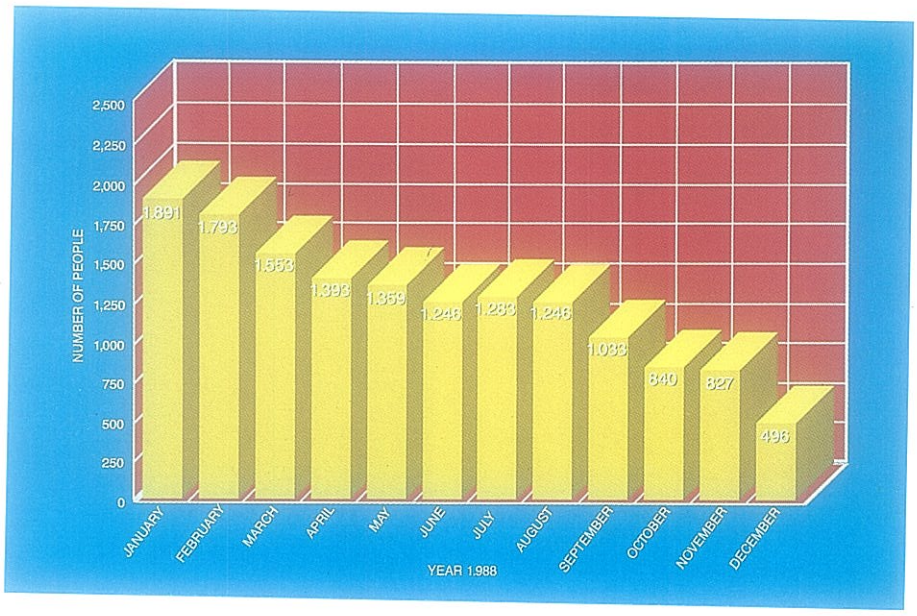


F II *Unscheduled trips during nuclear tests in kWU reactors*

F III *Unscheduled trips, shutdowns and power variations since commercial operation*

INCIDENT	DATE	DURATION (DAYS)	POWER	CAUSES	SYSTEMS/EQUIPMENT INVOLVED
DNP	24/8	0.3	100%	D (OP)	Feedwater loss.
PNP	3/10	4	100%	A	Review & cleaning of pilot valves of the pressurizer safety valves.
PNP	24/11	10	100%	A	Review & repair of condenser leaks.
PNP	24/12	7	100%	A	Modification & review of pilot valves of pressurizer safety valves.
DNP	25/4	0.5	100%	C	Main pump 2&3 loss.
VPNP	5/11	3 h.	100-30-100%	A	Main pump failure.
VPNP	10/11	24 h.	100-98-100%	A	Condenser pump break.
VPNP	22/11	5 h.	100- 0-100%	D (ME)	Turbine trip.
VPNP	8/2	11 h.	100-98-100%	A	Condenser pump break.
VPNP	7/4	3 h.	100-33-100%	D (OP)	Feedwater pump.
VPNP	7/5	12 h.	100-98-100%	A	Condenser pump break.

F IV *On-site personnel evolution*



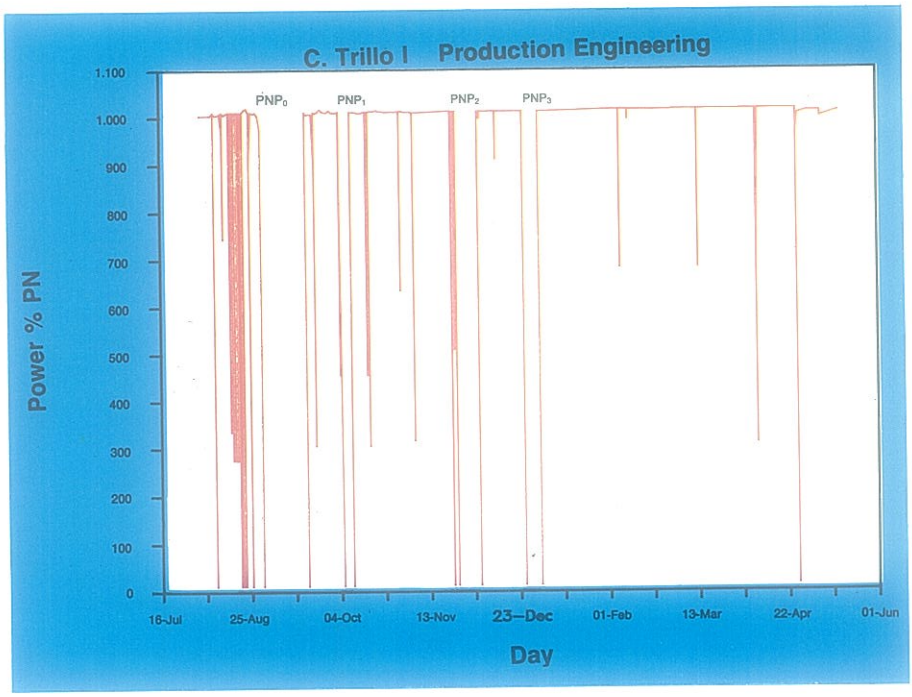
the main steam relief valves were modified and the secondary side steam generators were cleaned (approximately two kilos of material per steam generator).

Contrary to the scheduled shutdowns (which are planned and studied in detail), the unscheduled shutdowns occur for reasons that are worthwhile evaluating in order to prevent their reoccurrence insofar as possible and to maintain the plant in optimum conditions.

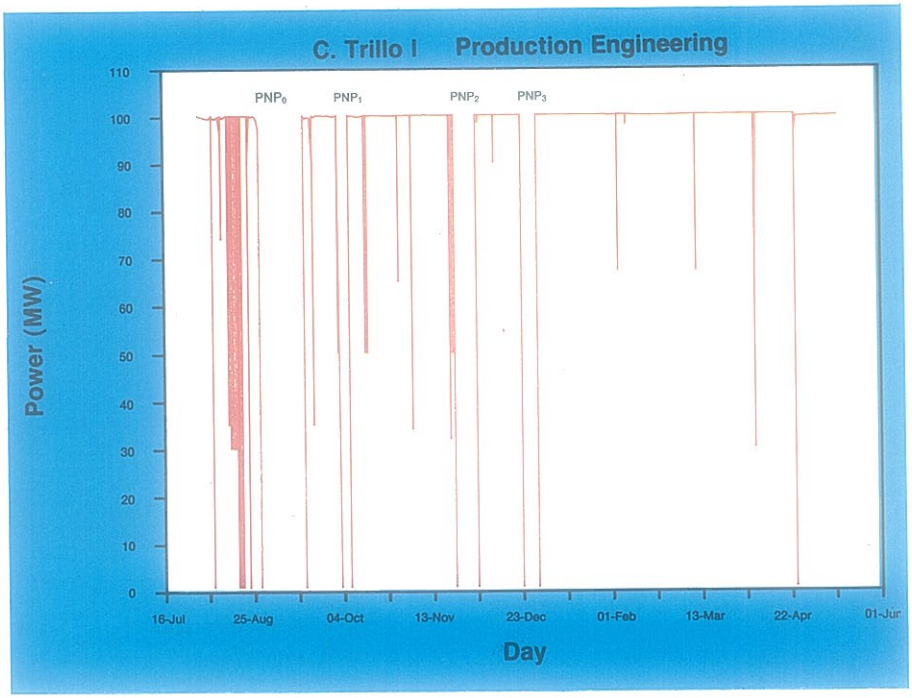
After each unscheduled shutdown, a report is prepared and an analysis meeting held to see if all parts of the Organization have responded satisfactorily and if valid conclusions can be reached for subsequent shutdowns or if they can be prevented.

Since commercial operation began, there have been three unscheduled shutdowns (PNP), as shown in Figure III. PNP 1 and 3 were a result of the review and cleaning of the primary side safety valve pilot valves. A design modification is being studied that would prevent this problem. Already in the second shutdown, lines were cleaned to prevent them from becoming plugged up.

On the other hand, PNP-2 was caused by damage in the condenser resulting from detachment of the extractor protective plates. This was mended and repaired as best possible; a modification of the support system for reloading is being studied.



F VIa *Thermal power since commercial operation*



F VIb *Electric power since commercial operation*

INSPECTION REPORTS AND EQUIPMENT & COMPONENT REPAIRS

This includes all maintenance jobs for which reports are prepared, due to their importance or to the detection of a defect to be remedied, in order to analyze the damage, the possible solutions and to make both operating and maintenance recommendations.

The reports indicate the component's state, the probable cause, the corrective measures, the tests to be performed upon completion of the job, the final operating status and the pertinent recommendations.

These reports are commented on by the plant services and by the support group.

EVALUATION OF HUMAN RESOURCES AND AVAILABILITY INDICATORS

Figures IV and V show the evolution of human resources during 1988, which includes the entire nuclear testing phase, and 1989, which was the first year of commercial operation. We can observe the effort being made to provide sufficient human resources for performing the tasks inherent in a plant in operation and to keep it within the margins of profitability.

Figure VI shows an evaluation of the production indicators.

For the first year of operation, the data are as follows:

	1989 %	Accum. %
Usage factor	95.81	73.92
Scheduled unavailability factor	3.26	11.39
Unscheduled unavailability factor	0.96	8.82

were analyzed before restartup. The injection operations and the advisability of some modifications are being studied.

OPERATING INCIDENTS

This paragraph refers to a series of plant incidents that do not cause a trip but do affect its availability and therefore require an evaluation of the plant's behavior during the transient. These events include the following:

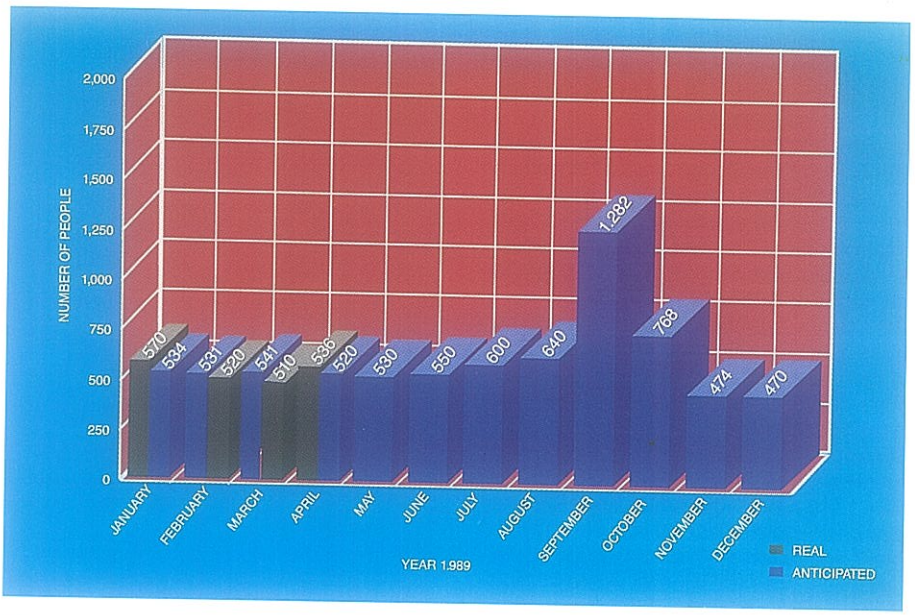
— Turbine trip.
— Disconnection of a main pump
— Disconnection of a feedwater pump
— Load rejections

as well as any other incident that merits study due to the characteristics thereof. The analysis of Operating Incidents involves two phases:

PHASE I: Investigation, analysis, appraisal and report.
PHASE II: Evaluation of the operating incident.

In Phase I, the situation is analyzed in order to return to the initial conditions (this is performed by operating personnel).
In Phase II, the incident is evaluated and, if necessary, corrective measures or recommendations are proposed (this is performed by technical service personnel).
In all, around 31 incidents have been analyzed: all of those that caused load variation are shown in Figure II, in the table of operating incidents. Of these, the following are noteworthy:

— Undesired opening of the three main steam isolation valves during the plant heatup phase.
— Actuation of the Limitation System YT, LOOP GW30 and KMT GWW, due to a YA10 T001 measurement error.
— Trip of a condensate water pump due to a spurious condenser level signal.
— Turbine trip due to high temperatures in the alternator cooling gas on filling the UH cooling water system.
— Turbine trip due to strong vibrations in turbine bearings with the alternator synchronized with the mains at load zero, after fifty minutes have elapsed in the total load rejection test.
— Safeguard voltage loss without diesel startup during grounding detection jobs performed in the scheduled shutdown in September.
— Primary pump trip due to a spurious caused by vibrations in the axial bearing temperature meter.
— Turbine trip caused by low cooling water flow in stater coils due to MI range.
— Load pump trip due to low pressure in sealing water on opening a demineralized water valve of the sealing manifold.
— Emergency diesel startup due to work on cabinets.
— Feedwater pump trip due to an operating error.



F V *Anticipated evolution of human resources in 1989*

SCHEDULED & UNSCHEDULED SHUTDOWNS

Since the Provisional Operating Permit (PEP) was granted, the scheduled shutdowns (PP) anticipated in the nuclear verification program have taken place.

PP-1. This is the shutdown following the second functional hot test and it lasted from 5-2-88 to 23-4-88. During this shutdown, the main pump internals of the flow rectifier were exchanged (including design change, replacement) for a sleeve, as well as the materials and fabrication process, wire-to-wire inspection of the entire plant, and review and diagnosis of all the safety system valves.

PP-2. The shutdown following the nuclear test phase at 30% of rated power. This shutdown had to be moved ahead of completion of this phase due to failure in the main steam relief valves. It lasted from 2 to 22-6-88.

PP-3. The shutdown following the nuclear test phase at 100%, during which