Compliance as a Strategy

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Preliminary draft - Comments welcome

Abstract: Social actors participating in any organization are expected predominently to develop informalities and arrangements in order to perform their work. The formal structure of an organization never totally describes the reality of the organization, but is constantly violated by actors practices, which never totally respect the prescriptions, procedures or rules in effect. Nuclear Power Plants in this respect, even though they are posing specific problems regarding notably the heavy use of procedures, essential to their functioning, should not depart from this general assumption made about organizations in general. This paper reports the results of 3 studies made at 3 different nuclear sites between 1991 and 1993, and shows that not only rules can be followed if actors have an interest in doing so, but also that not following them has more to do with a specific way of organizing activities than with a general property of all orgnizations.

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[1]I would like to thank a number of persons who have been following this project at various stages, both in France and in the U.S. First of all I would like to thank the plant personnels from Bugey, Diablo Canyon and North Anna, for their time, their patience, and their honest answers. A number of discussions have helped me in writing this paper. Therefore I am deeply grateful to Todd La Porte and Gene Rochlin, who accepted my stay at Berkeley, Craig Thomas, and Chris Ansell at Berkeley, my advisor Werner Ackermann and Geneviève Beaumont from the Commissariat à l'Energie Atomique in Paris. I am thankful to Nelson Polsby and the IGS staff, Adrienne Jamieson, Eunice Baek, and the IGS librarians, Terry Dean and Marc Levin for their warm hospitality and their good humor during these 2 years. Their support during all the phases of the field work has been a great encouragement.

"That rules can be changed by humans is one of their key characteristics". Eleanor Ostrom, "An agenda for the study of institutions", Public Choice, vol 48, 1986, p.6

Introduction

The main concern of this paper is to clarify the reasons and circumstances under which social actors decide whether or not to follow work procedures.

While it may seem reasonable to assume that procedures are meant to be obeyed, a number of scholars have argued that social actors do not typically work by the rules. Instead the requirement to perform their jobs often leads them to find ways around. For instance, the strategical analysis (Crozier and Friedberg [1977], and Friedberg [1993]) embarking on an older tradition[2] (the "Human Relations" movement, March & Simon [1958], research on bureaucracies Gouldner [1954, 1955], Crozier [1961 and 1964], Downs [1967]) emphasizes the distinction between the 'formal structure' or prescribed organization and the 'informal structure'. This approach, based on a long tradition of monographs and empirical studies, suggests that the formal structure never fully encompasses the reality of the organization. Rather, the prescribed organization is constantly infringed by social actors practices which never totally respect the formal procedures. As a result there exists an irreducible gap between prescribed work and real work: the former never matches the later.

Consistently, this view has directed attention towards understanding the modus operandi of the informal structure: actors are perceived as having a certain amount of freedom inside a set of possibilities, and as

[2]Driven itself by the critic of the weberian 'ideal type' of bureaucracy, especially aiming at describing dysfunctioning and inefficiency of bureaucracies.

opportunistically making the best choices for them given the constraints they face (resources, status, position). The task of the researcher is then to uncover the various adjustments that took place in the organization under study, in order to clarify their logic. Although they recognize that the formal structure may contribute to shaping the informal organization, it constitutes at most a constraint among others [Friedberg 1993 p147]. Finally in this view informalities become the norm and are expected to emerge everywhere[3].. Informalities and tacit rules are at the core of collective action.

We should point out that the distinction between the informal and formal organization is still present in Meyer and Rowan chapter [1991] where the informalities must be developed by social actors participating in organizations in order for them to make up for the discrepencies that the formal structure impose on them.

A recent study [Terssac, 1992][4], influenced by ergonomic research which has come to complement the work of the sociologists mentionned above, goes further in proposing a general theory of the relationships between the work group[5] and the management's group, showing why workers have no other alternative but not to follow the procedures and

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[3]"The control of the formal structure is never complete. It is constantly circumvented by a number of practices that do not follow its prescriptions [...]. Examples of such patterns abund and can be found in every organization, regardless of its statutes or goals. [Friedberg 1993, p145, translation is mine].

[4]This theory is of high interest to this research because one of the case under study is French Nuclear Power Plants and more broadly complex organizations dealing with complex technologies [chemical industry] . Organizations, which are typically often seen as less prone to let margins of autonomy develop, because of their stringent rules of operations.

[5]We designate by "work group", the workers who actually perform physically the work.

why despite the danger and the clandestinity they are in, they have no interest in changing the rules of the game. The author argues that prescribed rules have 3 main characteristics: (1) they are always created *outside* the work group (2) they are meant to *influence* the behavior of the work group (3) But unfortunately they can *never pretend to accurately describe* the reality that workers face in their daily activities because they cannot thoroughly address the various surprises and uncertainties encountered in real life situations.

Consistently, both workers and management, recognize implicitly that arrangements and informalities are inescapable. The management expects workers to find ways to follow the requirements of a sustained level of Production, even if this means that they will be put in a position of having to violate current rules. On the other hand, the work group accepts to fulfill those expectations because the implementation of these implicit requirements is left to their discretion.

A particular category of organizations which has recently come under closer scrutiny by organizational theorists (Perrow [1984], LaPorte, Roberts, Rochlin, Schulman [1987], [1988], [1991], [1993]) poses a strong challenge to that view: Nuclear Power Plants, Chemical plants, Air traffic control systems, or Large complex military systems all require to be operated by a series of stringent rules. Guidelines, procedures, and compliance thereof are essential to the very existence and legitimacy of these organizations. Traceability of the work, history and records of every activity are key dimensions of the organizational life of these organizations. Their errors can be not only fatal or extremely dangerous, they are also extremely visible to the outside world.

With this in mind this research was initiated as a study of informalities in highly hazardous environments. If the predictions of the informal organization model were to be verified arrangements would play a crucial role in the ways those organizations were functioning. Quite paradoxically, in an extremely regulated and procedurized system where everything has to be scheduled and planned, dozens of little arrangements were supposed to be made every day, and to make the organization work: Although never publicly acknowledged, arrangements would be nevertheless responsible for the very functioning of such organizations. I was less concerned in my research with the problem of reliability than with the implications of discovering informalities in such organizations.

My research is focused on the study of 3 nuclear power plants, two being located in the U.S (Diablo Canyon, CA, and North Anna, VA) and one in France (Bugey). Those studies were conducted from 1991 to 1993, a total of 23 weeks were spent interviewing 225 employees, from all categories. I chose to study a particular time in the life of nuclear power plants, that is scheduled outages, where most of the maintenance activities are performed. This time period is one of the busiest and one of the most challenging for the organizations, leading to the emergence of a lot of interactions and cooperation in order to execute in a timely fashion hundreds of scheduled maintenance activities. At first, it seemed reasonable to expect sheduled outages to be perfect candidates of organizations in need for flexibility and arrangements.

While Bugey appeared as a perfect illustration of the informal organization model, thus strengthening my initial research hypothesis of an operational

role of informalities, Diablo Canyon imposed it self as being dramatically at odds with this view. This gap led me to reconsider the very principles under which I had undertaken my study. In particular, not discovering any clearcut informalities in Diablo Canyon suggested to recast the whole question: In other words the problem I faced was not so much to understand *how* infomalities operated, but rather *why* did they emerge?
The remainder of the paper is organized as follows: the first section sets the stage, and gives an idea of the organizational characteristics of nuclear power plants. Section 2 describes the arrangement pattern as we observed it at the French plant of Bugey, and its modalities. Section 3 contrasts these findings with the results of our fieldwork in two American plants: they suggest that arrangements are far from being a general and encompassing modus operandi. In conclusion we provide an explanation for these surprises based on our empirical evidence.

Section I: organizational features about Nuclear Power Plants.

I began this project in the summer 1991, with a study at one of the oldest French Nuclear Power plant, Bugey [on line in 1972, 5 units, 4 PWR, 1 "graphite-gaz"]. This study indirectly followed a request from EdF [Electricité de France] to have sociologists study nuclear power operations and especially maintenance activities. A series of events had triggered such a request: in summer 1989 a couple of disturbing mistakes had been reported to the regulators [Dampierre and Gravelines] and therefore a better understanding of what was happening at this period of the cycle [refueling outages] appeared to be of interest.

I-A-General design of nuclear power plants:

The three nuclear power plants under study are divided along one principal line, which is the separation between the operations department and the maintenance department. The first one is concerned with the normal operations of the plant, that is producing power, the later with the various repairs and revisions necessary to keep the equipments running. Electricians, instrumentists, mechanics, boiler-makers, welders, machinists constitute the main forces of a maintenance department. From the control room, operations people "fly the plane", under the supervision of a shiftsupervisor, his assistants, the licensed operators and the auxilary operators who are responsible for several walkdowns (inspections) a day. The operators are the "producers" of the electricity. They report any problem regarding the equipment, any suspicious malfunction. The maintenance department takes care of the refueling outage where most of activities can be done because the unit is shut down. At this point there is a partial transfer of power from the operations department to the maintenance department. The degree to which this transfer is actually effective in the field varies from one organization to the other[6]. In order to undertake maintenance activities the jobs have to be planned and scheduled. Planned, because there is not a single activity that can be performed without a work-package, including a work-order, the adequate procedures for each and every sub-activity, a radiological permit, the protective equipment required, a fire permit if needed, a list of parts to use. All these documents require to be signed off at various stages by the foreman, the worker, the QC inspector. Scheduled, because more than one

[6]Maintenance work can also be done during the operation of the plant - usually under emergency conditions.

department has to be coordinated. Any maintenance activity requires at the minimum the assistance of the operations department. The operations department is responsible for the authorization of the work on the various components, and shiftsupervisors authorize maintenance activities by signing the work-packages. Concretely, only operators can disconnect, and prepare the work-place for the maintenance crews. Despite the fact that the unit is shut down, the materials, components and circuits are not all at once available. Stringent requirements have to be observed in order for maintenance to be done[7].. Specific drawings, the "master taggouts" help the operators in concordance with maintenance personnel to determine boundaries on the plant systems in order to allow work to be performed safely[8]. A couple of terrible stories of accidents circulate around each site we visited: a storytelling effect as Weick [1987] would have explained it to keep workers aware of the dangers.

Each site seems to have its own way of handling this necessity of cooperation between 'Ops' [Operations] and 'Maintenance'. The coordination between these two main groups carries a lot of tensions, largely due to their antagonistic missions:

> *"We have different missions, our job is to make the plant better than when we got there in the morning, in order to do so our work involved changing things...we have to be out changing equipment each day. Ops, their goal is to run the*

[7]For example, water has to be drained out of the circuits, activities of decontamination have to be performed prior to any kind of revision, then the core has to stay under water, which means that the operators have to keep certain types of valves and pumps, called "functions" available to them. Most of the components are doubled with redundant equipment which means that when maintenance is performed on one piece, the other one has to stay untouched and available at any time.

[8]When a crew work on an electrical equipment, it has to be taggout and permanently disconnected in order to avoid any mistake which could lead to an accident. When a worker works on a valve, the taggouts people have to make sure that no water will suddenly flow, because somebody else is doing a test up-stream and needed water.

plant safely from a nuclear safety point of view, their goal is not to change anything, everytime we want to do something, it means a disturbance to them and they will fight us...there's a natural tendency on ops part to do things carefully and slowly" [Superintendant Maintenance, North Anna].

I-B-What kind of problem is an outage?.

Outages represent one of the most challenging time for nuclear power plants: the complexity of the activities involved requires an enormous effort of cooperation, non only inside the plant between operators and maintenance crews, but also with contractors[9]. Contrary to the normal operation of the plant where there is relatively little uncertainty in the way the plant is going to be run, an outage carries a lot of uncertainties and surprises that will need to be dealt with immediately. In addition the cost of an outage is so high that its duration has to stay under close control. The time constraint is unavoidable and represents one more challenge that workers have to face. Longer hours and overtime are common. The activities that will be performed have sometimes no precedent, which render difficult their planning and scheduling. For all these reasons, these outages are likely candidates to display informalities, arrangements and tacit rules. Under time constraints and with lots of uncertainties to deal with, it is very likely that patterns of arrangements will be discovered.

A scheduled outage involves several activities: 1) refueling part of the core. This activity consists of unloading part of the uranium assemblies

[9]At Bugey, 70% of the maintenance activities were done by contractors; at Diablo roughly the same amont as well.

and replacing them with new assemblies[10]; 2) revising the material as the law prescribes it, testing, replacing some components; 3) repairing all the materials and components which are known to be defective or broken; 4) incorporating all the modifications of design that the law prescribes on operating reactors[11]; 5) facing the daily surprises and fixes that need to be done while performing the various operations described above. There is a relatively large amount of work that couldn't be identified prior to the outage[12]. In that case the outage management has to determine if the problems are serious enough to be fixed now, or if they can wait the next scheduled outage. The arbitrage between deciding to fix the problems now rather than wait the next outage, with the risk of increasing delays or postponing what needs to be done in order to save the schedule is a key decision that outage managers have to make.

In order to achieve these various missions, the utility enters in a labor intensive process, very demanding to both in-house crews and outside contractors. Maintenance personnel have to perform their jobs as quickly as possible, which often means "do it right the first time", but they always are required to follow the procedures associated with their work and must

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[10]Most of this activity is done by a robot, actually a crane, but radio-protection workers and techniciens have to monitor the whole activity, which usually take several days.

[11]Mainly the utilities are dealing with post-TMI modifications, though most of them are complete, fire-modifications and various other ones depending on the histories of various components. Some plants in France are engaged in a very costly process of changing the vessel heads of their reactors because cracks have been discovered on some of them.[see Le Monde oct 1991]

[12]The percentage of unplanned work can vary, I think it is fair to say that around 30% of the work that is going to be done during an outage in not scheduled. This number is extremely debated because of course the more unplanned work is discovered, the more likely the outage will last a couple of extra days. Most of the outage managers we talked to strongly indicated that the preparation of the outage is still an area where a lot of improvements can be done. The goal is to be able to plan a maximum of activities in order to avoid more and more of costly surprises.

stop the work if they cannot follow word by word what is written. A typical work-package is made of a work order, which basically tells the worker the location of the job, a brief description of the problem, the parts he has to ask for at the warehouse with their number, the permits he has [fire-permit, radio-logical] to carry with him. Then the procedures he will use, if it's a valve he will carry a procedure for the tear-down, then one for the visit he has to do, another one for the re-packing, several instructions from the vendor's manual. The tooling he needs to use will be specified. Throughout his work, he must record the specific figures of his activity in the procedure, and he must write comments at the end, which will be typed later in a computerized system[13].

During an outage, the pressure on the maintenance crews is constant, their supervisors must report at least twice a day on the progress in the field, a single delay will be watched closely, increasing the pressure already present on the crew members.

The contractors face even greater pressures, most of them are working under fixed price contracts, which means that they agree with the utility that they will perform a certain type of activities for a certain price. If something comes up, which necessitates additional work, they basically are obliged to do it for free. In reality, they always exaggerate the amount of time they need in order to perform the requested activities, which gives them some margins in case of unforeseen problems. Most of the utility's managers in charge of writing up contracts with contractors are aware of their tendency to overcharge, which lead them to renegotiate the amount of

[13]Some differences exist in the composition of a work-order associated with a work-package. Some are very detailed and given to the foreman almost complete [Diablo Canyon], some look more like shopping lists and the preparatory work still remains the foreman's job [North Anna].

time needed. Overall the margins that contractors can built in their contracts are rather small.

One has to imagine that the worker is not always in a comfortable area where he can easily write his comments. Most likely, he wears rubber gloves, rubbers covers on his shoes, a hood, a long coverall, safety glasses[14], if the area is contaminated he may have to wear a respirator, a bubble suit[15]. This equipment is uncomfortable, awfully hot inside, the sticky straps often fall off and the precision of the moves are rather approximative. Nevertheless the worker, who carries on top of everything his dosimeter with an alarm incorporated in case he accidently passes by a highly contaminated area or in case he reaches his limit of contamination (which is monitored closely by the radio-protection department) and his radiological film, has also to take with him the work packages. Most of the equipment and tools he will need if the job is located inside the containment will be stored inside.

Monitoring the work on the job-sites is one of the toughest problem that plant managers have to face. Unusual jobs to perform, unforeseen problems, risk of delays, additional work-force whose integration is difficult to predict, time pressure and personnel safety concerns during tricky maintenance activities are at the core of the daily problems that an outage carries.

In order to face adequately these problems, a lot of utilities have decided at the end of the 80's to design special structures only in charge of

[14]That one has to wear over prescription glasses.
[15]"mururoa" suit as the French call it.

the preparation and the execution of outages. In France they are called "structure d'arrêt", in the U.S they are usually called "Outage Structure", or "Outage Control Center". The three plants we studied display such structures, but the degree to which these organizations had control over what was happening during the outage varies. Briefly I would like to summarize the characteristics of such organizations. They are meant to be temporary, focusing mainly on the schedule issues. They are usually staffed with representatives of the various departments involved in an outage [electrical, mechanical, I&C sections, warehouse, taggouts people, schedulers, engineers,] and directed by an outage manager, whose main purpose is to keep the schedule under control, or to find ways to face any unscheduled problems. These representatives must feed the outage manager and their colleages with information on their area, giving status reports on the progress made in the field. In return the outage manager and his staff convey to the representatives the information they need to either speed up the process or to evaluate the remaining time they can use before getting in the way of another group ["critical path"].
The role and status of these temporary organizations vary and the three plants we studied had made a different use of this type of structure.

Mainly, we would like to reemphasize the fact that confronted with these kind of problems, outage organizations were typical candidates most likely to carry a lot of informalities and arrangements. As the theory has predicts we were expecting a classic discovery of tacit rules, and unwritten practices aiming at performing difficult jobs, under time pressure.

I-C- Attempt to define what informalities are with regard to the context of the study:

Informal networks, bricolages, arrangements, tacit rules, informalities, deviant practices, short cuts are common expressions of the discretion that social actors have over the rules and procedures they are supposed to obey[16]. This paragraph is an attempt to clarify what we are talking about. We will be using examples from our case studies to illustrate this section.

Even though these terms could have a large variety of meanings and purposes, one should consider that they in fact belong to the same category. The informalities can take several forms, from the unexpected development of informal work relationship between 'préparateurs' and contractor-foremen in order to overcome problems discovered in the field to a clear short-cut in a procedure to make up some time.

Informal networks involve usually people who have no formal relations, they are not even supposed to work together, and some may not even recognize that in fact they have a relationship. Informal networks express discretion that social actors have over the way the work is divided among them. By developing marginal relations, they stress the fact that they need to rely on additional information in order to perform their jobs.

Informalities can constitute a more or less stable system. "Deviant practices" are usually one time arrangement, calling for a punishment. Or informalities can also constitute a system and be called "tacit rules". .The tacit rules are a series of unwritten rules which exist among a particular

[16]We exclude from our analysis the "sabotage", because in that case there is a clear intention to jeopardize something critical.

group and refer to their daily operations. Violating these rules is as severe as violating formal rules, probably even more. Gouldner's description [1954, Wildcat strike] of the resentment that workers had during the succession crisis at the gypsum plant, where the "indulgency pattern" got destroyed by the new management is enlightening in this respect. An example of tacit rules was found at Bugey: it is not allowed for a supervisor to report wrongly the number of overtime done by its subordinates. Nevertheless, it is accepted practice to see the supervisor adding a few hours to the total of overtime hours to please his subordinates. The craftsmen expect this arrangement because they will benefit from a higher salary, and by doing that the supervisor knows that he can count on people each time there is some overtime to do, because people think it's worthwhile. It is also a tacit rule to stretch the week and not finishing the work on Fridays, which leaves some work for Saturdays or Sundays, where people get not only overtime pay but double pay. In a system where no bonus for extra good work is allowed[17], the supervisors find ways around to reward people willing to work overtime on short notice. The upper management knows it but has no interest in stopping the cheating.

The bricolage expresses a somehow different idea, at least when it is used by the craftsman. For the craftsman a bricolage means that he had done a non-permanent repair on something, a quick fix that should not last, something he knows does not comply with the state of the art, something he was forced to do because he had no alternative. A bricolage is safe as long as it is well understood that it's a temporary measure.

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[17]Typically the case where unions decide on the wages.

By extension, social scientists [Duclos 1991, p.27] start using the term to speak about arrangements, informalities which do not contradict the overall safety of the organization but which are not to be found in any book, procedures or guidelines. Bricolages are usually not built in system, they are more like short term arrangements, unlike tacit rules which are more embedded in long term strategies and stable equilibrium.

Even if these arrangements are common, even if almost everybody can recall a situation similar to the ones describe above, arrangements and informalities develop themselves under specific factors. This article is aiming at providing some knowledge about these factors.

Section II- The Arrangement's Pattern at Bugey:

Bugey's study began in May 1991 and I stayed on the site for a total of 6 weeks. 65 persons have been interviewed, mainly in the maintenance department, but the key criteria was their involvement in the conduct of the refueling outage of the Unit 5.

II-A- Two examples of Informalities at Bugey: The construction of a system.

I would like to illustrate with two examples the type of organizational logic Bugey is involved in. One of our arguments discussed in an earlier paper[18] was to show that having to develop special informal contacts in order to adequately perform a job, or having to cope with an incomplete procedure which meant at Bugey having to proceed without asking and still be able to do the job right had a lot in common. More broadly speaking this pattern was a typical "pattern of arrangement" present at Bugey in various forms.

II-B-a-First informality: The special role of an Operations Engineer:

The existence of a cleavage between the operations department and the maintenance department forces the emergence of mediation practices between the 2 groups. This mediation takes place in the "structure d'arrêt" but no formal interaction has been designed[19]. It is largely up to the

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[18]Bourrier [Nov 1991]: "Complexité du travail et coopération dans une centrale nucléaire, interrogations autour d'une structure d'arrêt". Working paper, Centre de Sociologie des Organisations.

[19]There is little scheduling or preparation aiming at smoothing the potential problems the 2 departments could possibly face in the field.

participants to resolve conflicts and problems between the 2 departments. At Bugey, the main problem is a problem of "substitution": When the maintenance crews face a delay, or an unplanned situation, usually they try to resolve it alone without calling for help; in some cases they cannot fix it in the time frame they have been given so they will have to warn their representative at the "structure d'arrêt", who are also their General Foremen, that their delay may impede somebody else's work. This usually is a bad news which calls for the outage manager to think of a "substitution": The job that was supposed to start right after the problematic one will be delayed as well, and something which is not impacted by the delay will start instead. In order to do that the whole plan has to be disturbed and usually the operators have to prepare the job site rapidly on short notice. They will possibly have to change an alignment or put a circuit in another configuration, many little moves they hate to do, especially on short notice. Operators hate to do things in a rush, besides they are much comfortable on well routinized procedures, the ones they do all the time. During outages a lot of the configurations they are asked to do are new or unfamiliar to them. In addition, since operators work on shift, it often happens that a shiftsupervisor had given his okay to do a certain substitution, but the next one disagrees with it. The outage manager alone doesn't have the power to command the operators, especially the shiftsupervisors. He originally works at the maintenance department, he cannot give orders to any of the ops people, even though he is the outage manager. Thus, they can easily refuse to do the substitutions asked by the outage manager. Unfortunately if these substitutions cannot be made, the outage schedule is at risk. The outage manager has to find an ally in the operations department, but not only him the general foremen as well. This

ally is found in the person of an ops engineer. This man is formally in charge of the clearances and taggouts section for the outage, but he has no authority over the shiftsupervisors either, he can only try to convince them. Nevertheless his role emerges as key for the outage's functioning, because he is in a position to control an uncertainty on both sides, the maintenance side and the operations side: He knows that the General Foremen are often running into problems, which may if not treated early impact the schedule. However, the General Foremen are usually terribly reluctant to confess their difficulties during outage meetings, afraid that upper-management will take the opportunity of bad news to look closer at their job-sites. The General Foremen will only confess if they are sure that it will be almost unnoticeable by the upper-management. In order to stay secret, the substitutions between job-sites have to happen early in the process, well before severely impacting the schedule. An early declaration is sometimes difficult to decide because the Foremen usually hope they can catch up their delays. Therefore, early and honest determinations are key to the management of the schedule. On the other side, the ops crews are reluctant to execute unplanned changes and they often refuse to do them, stopping for example the work for a whole night, which they are entitled to do[20]. To prevent this from happening, one has to plan as early as possible potential changes, in order for these modifications to be accepted by the shiftsupervisors. The shiftsupervisors really hate the disturbances caused by an outage, they hate seeing so many people they hardly know, especially contractors working on "their materials", they hate taking responsibility too closely related with a change of plan, and a rearrangement of alignment

[20]The compliance with this rule is clearly strategic.

is usually badly received by the ops crews.. The ops engineer knows their fears, and offer his help as a comforting hand. He will design the changes for them, write them down, and more importantly he will take the responsibility to explain them to the next shift, staying late in order to meet with the next shiftsupervisor. The ops engineer then controls two uncertainties for the 2 main groups which have to deal with one another. But he also knows the limits of his mediation. He can only help out the maintenance people, if they come up-front and tell him early in the process the problems they face. If he is aware of the problems soon enough, he has the time to write down a change of plan and work the difficulties with the shiftsupervisors. This role has emerged from the necessity to give some margins to the maintenance without having the operators opposing the type of substitutions needed. Without this go-between, the maintenance crews could not bridge over with the shiftsupervisors.

This configuration is an example of clear case of an informal role emerging from a potentially problematic situation. This man controlled such an important uncertainty for the outage, that he eventually became the true leader in the "structure d'arrêt". But his role has no formal authority, nor a formal job description.

This pattern of arrangement is only one example of the myriad of little arrangements commonly made by the social actors of Bugey in order for them to perform their jobs.

II-B-b-Second informality: The impossibility to follow procedures.

Working with procedures was one of the toughest problems workers and their supervisors had to face. A clear system of tacit rules existed, largely echoing the impossibility for workers to follow procedures. The maintenance procedures were designed by the "préparateurs", a group of 12 people, who were in charge for the 5 units of all the procedures, from their design to their up-dating. Two months in advance they were getting ready to prepare the outage coming ahead. Actually the outage, I studied in particular started without having all the work-packages and procedures ready, because of a lack of time and the introduction of a new computerized system (Sygma), which took some time to master by the préparateurs. During the preparation of the outage, the preparateurs have to write the procedures, correct them if necessary, contact the vendors for ordering parts, and make the contracts with the outside-contractors etc.... But once the outage starts, they basically disappear from the outage's scene, already busy with the preparation of another outage. The préparateurs do not seat at the "structure d'arrêt", but they are supposed to stay available to the workers if they need any help. In reality, the people who are responsible for the design and up-date of the procedures are not available. On the other hand, workers confess that they do not follow the procedures because "they know what to do" and they are "professionals".

> *"A pump making noise, it is not the procedure which is going to tell me what's going on" [Foreman, Bugey].*[21]

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21 *"Une pompe qui fait du bruit, c'est pas la gamme qui va me le dire" [Contremaître SUC, Bugey]*

The possession of a "métier", welder, mechanic, or electrician implies a deep socialization and learning inside the group they belong to. The craftsmen resent strongly the proceduralization of their work, they interpret this phenomenon as a lack of trust from the management's part. For example the introduction of a new computerized system, "sygma", where all the records should be entered is resented:

> *If we want to work 100% with Sygma, the outage will last at least one year, we are out-laws, Sygma it's good at the beginning. [General Foreman, Bugey*[22]*].*

Their quality of welder, mechanic or electrician provide them with the intimate knowledge of the components and materials, they claim that they are the only one who know how the component has been repaired in the past, and no procedure can tell them what they really need in order to perform state of the art work. The workers are often referring to a set of tacit rules that they shared with their foremen, who are presented as the ultimate referent.

> *With C, we got used to it, that's his main advantage as well as his main drawback, he's an out-law, we don't have all the information but we know what we are doing, management knows that, but C is so resourceful, if one day someone has him involved...[welder, Bugey]*[23]*..*

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22 *"Si on veut travailler à 100% avec Sygma, alors l'arrêt il durerait un an, on est franc-tireur, Sygma c'est bien au début" [General Foreman, Bugey].*

23 *"Avec C, on a pris cette habitude, c'est son point positif comme son point négatif, il est hors la Loi, on n'a pas toutes les billes en main mais on sait ce qu'on fait...ça se sait vachement haut mais il rend tellement de services...si un jour on le met en cause ça va faire du bruit". [welder, Bugey]*

The discretion that workers stress is also strongly associated with a sense of censorship, that they as a group imposed on themselves.

> *We are out of tolerance, but it's OK, we systematically add 10%, it's not that much...well we do not exagerate and put more than 20%...but everybody knows that here...and also sometimes we only fill out the procedure afterwards. [Mechanical Foreman, Bugey].*[24]

This common socialization and strong belonging to a "métier" are not exogenous to the fact that it is virtually impossible anyway for the craftsmen to have the procedures changed when they need it, that is directly on the spot. Because of the time-constraint and the fact that nobody in the field has the authority to change anything on the procedures, they adjust to this situation by re-creating a new set of rules, which are not only followed but enforced. It was clear for these men that deviant practices, which could jeopardize the safety of the plant and the population were inadmissible. Besides, it could mean that the upper-management might be aware of problems in the field, and decides to look closely at the work done in the field. Therefore a set of self-imposed censorship characterized the informal practices of the workers and their foremen.

This censorship and the system of tacit rules, which governed the way workers were performing their jobs at Bugey were in fact best discovered at the favor of a couple of very important organizational changes experienced at Bugey at the time of the study [see figure]. In

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24 *"On est hors tolérance mais ça passe quand même, on rajoute systématiquement 10%, c'est pas énorme...bon faut pas charrier et mettre 20% de plus...mais tout le monde le sait ici....et puis comme desfois on remplit la gamme après..." [Contremaître, mécanique, Bugey].*

brief, a series of new dispositions regarding the use of contractors on site, has dramatically changed the social system at work at Bugey. But, we would like to make clear that at this point we are using this reform as an exogeneous factor, which disturbed what we wanted to study. Thus, leading us to better understand the very role of informalities at Bugey, in the light of a crisis.

First of all, a new Work-Law [Law 90 613, July 12, 1990, Code du travail] forbid the use of contractors mixed with EdF craftsmen under the supervision of EdF foremen. Therefore, at the time of the study, EdF foremen who once reigned on all the craftsmen present on site, EdF agents and contractors, could only be responsible for EdF employees.

A second Arrêté, "Arrêté Qualité", August 10, 1984 (which took some time to be fully effective) obliged the contractors to be responsible for the first check on the procedures they are using (most of the contractors are using EdF procedures). In other words contractors had to self-assess and check that the work they performed was correctly done.

Concretely it meant that the contractors, now supervised with their own foremen have hardly any relationships with the EdF supervisors.

Aware of a possible undesirable increase of the contractors autonomy, directly resulting from the combination of these 2 new laws, EdF created a new function inside the organization, called "contrôleurs". Ex-EdF craftsmen, they are in charge of inspecting a couple of specific features about the jobs done in the field by contractors. On each procedure, some stops were included, requiring a contrôleur to be called in in order to inspect and sign that up to this point the job was correctly performed.

The contrôleurs were supposed to be a link between EdF authorities, and especially the General Foremen, representants of the work group at the "structure d'arrêt" and the contractors.

This re-organization led to a couple of disturbances in the way activities were managed informally: (1) The contractors became more and more independent and autonomous in the field, away from the supervision of EdF foremen. (2) To be responsible for the first check on the procedures they used was new to them and relatively risky, because they had to sign off and make sure that the work they were doing was correct, in complinace with EdF standards. This implied also a legal responsibility. Most of the contractors were willing to take this responsibility, if they were to gain from EdF some independence in the field. (3) The introduction of contrôleurs was therefore resented by contractors. (4) Contractors foremen didn't accept on their job-sites the EdF contrôleurs and most of the time forgot on purpose to call them. (5) The general Foremen at the structure d'arrêt expected a lot from this new contrôleurs, basically their only remaining link with the contractors, since the EdF foremen were only left with one or two job-sites and 6 men.

These changes in the field disturbed greatly the system of tacit rules that was in effect regarding the execution of the jobs: (1) Since contractors and EdF employees were blended together, a common socialization helped them to share a common set of tacit rules. (2) With the new law contractors are on their own. The EdF foremen frequently stressed that from now on what was done to the components and equipments will be partially lost, and that once the contractors are gone nobody will be able to tell what has been done. In a system where people are not used to record immediately what they have done, because they have experienced that changes they have asked

for are never incorporated in new procedures, the only way to know what is going on is to work closely with the people who actually performed the job. A lot of the relevant information are transmitted orally. (3) Before the reform, EdF foremen and General Foremen were the ultimate referent in case of problems. They were aware of any problems and constantly looking for problems which could degenerate in deviances. (4) At the time of the study, the General Foremen had lost a great deal of power, a power that had not been replaced by strong contrôleurs.

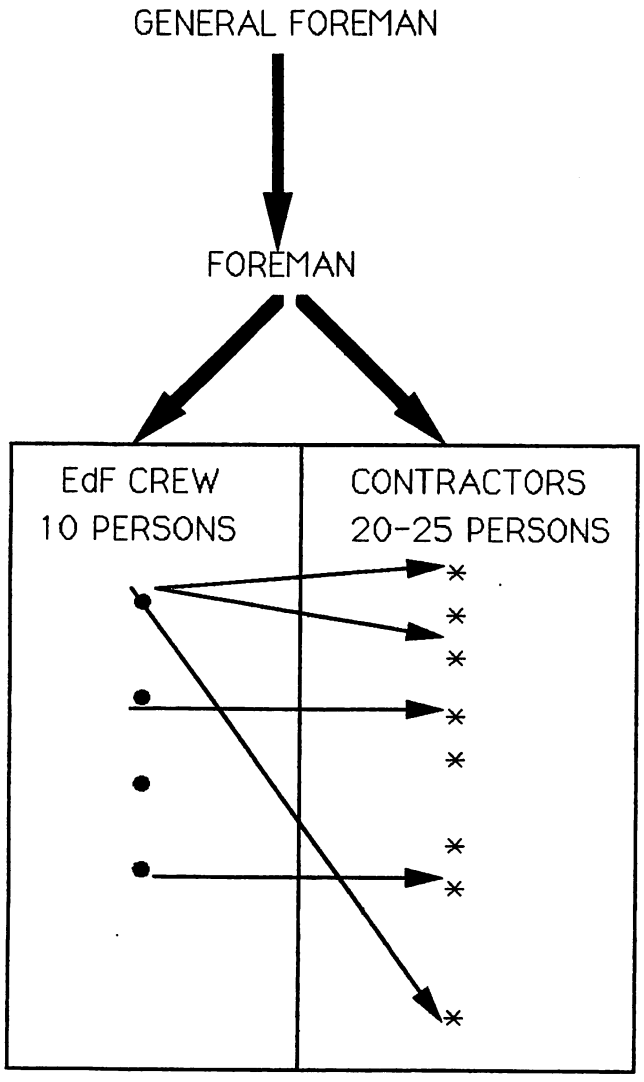
However, bad problems seemed to be avoided. Even though the tacit rules completely embedded in high socialization between workers, contractors and EdF employees under EdF supervisors had disappeared, the execution of the work appeared to remain safe enough, so that nothing terrible happened. Why is it so?

In fact the contractors Foremen began to knit more and more informal networks with the préparateurs. As I mentioned earlier, the préparateurs were absent from the structure d'arrêt. Besides, formally the only representatives that contractors had to have were EdF general foremen. Nevertheless, the contractors felt more useful to be advised by the préparateurs, especially when it came down to procedures. Interestingly enough, the contractors were more and more reluctant to be in a position where they had to violate the procedures if they didn't match what they found in the field. As a matter of fact, since they were now responsible for the first check on the procedure, and since they were susceptible to loose the contract with EdF if they missed something, they had clear incentives to follow the rules. Even though an easy access to the préparateurs was not given, they found a way to by-pass the General Foremen in order to gain direct access to the true knowledgeable persons on site, the préparateurs.

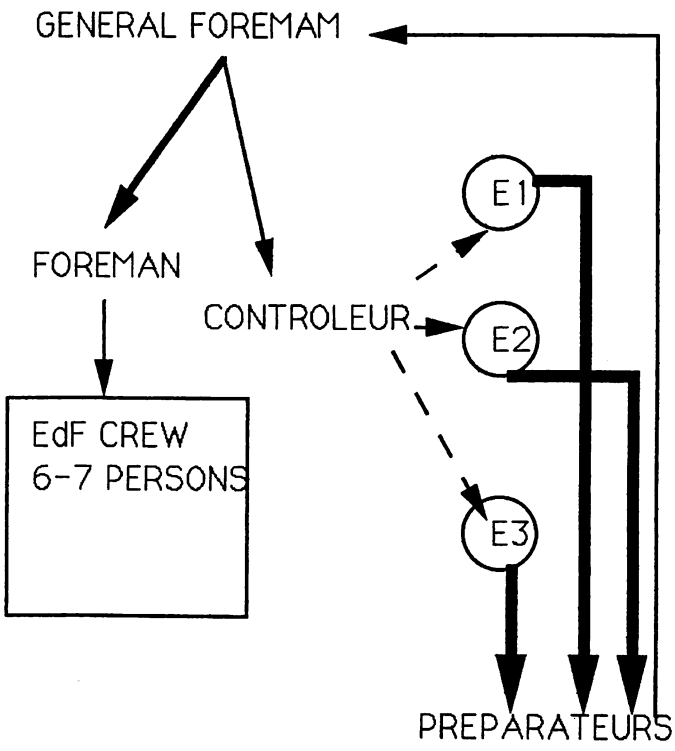
The other reason explaining why contractors were more and more eager to follow procedures as best as they can, lied in their new situation on site. Before they were heavily socialized with the EdF employees, and a great deal of information could be exchanged. Now that they are more outsiders, they need to rely more on records, typically on procedures, where history of the various repairs or problems should be typed in.
More importantly, the General Foremen aware of this new pattern from the contractors part, were willing to stay informed and manage to build a secret relationships with the préparateurs. Strangely enough, asked if they had any relationship with the préparateurs, the General Foremen would say no. Yet, in order to retain a little bit of their power and authority as chiefs of the field, based on their former ability to stay informed through their foremen, they had to find this information where it was available, in the préparateurs hands.
However, even if one can say that with the help of their ingeniousness and ability, social actors manage to find other ways to stay reliable, one should mention that préparateurs are no "field persons", they usually advice from their desk, which means that what is lost in this re-organization is the closeness of workers and the EdF supervisors.

These conclusions naturally led me to think that not only nuclear power plants were no different that any other organizations, since they displayed lots of arrangements and informalities, but that these arrangements were to be investigated as vectors of reliability.

BEFORE 1989



AFTER 1989
situation at the time of the study



E1, E2, E3: contractors working on site, now bringing their own foremen

Shift of power relationships at Bugey

Section III - Problems a research hypothesis: Confrontation with Diablo Canyon and North Anna:

The Diablo Canyon case and the North Anna case lead me to recast the hypothesis I had when approaching first Diablo then North Anna[25]. I chose to compare the Bugey case, with 2 others American plants. I had some restrictions: (1) The 2 plants had to experience an outage at the time of the study, (2) They had to be PWR, preferably Westinghouse design comparable with the French Framatome license, (3) Their power had to be comparable from 900 Mgw to 1100 Mgw. The technology in use at the three plants is roughly the same, the problems of producing power with this type of facility were comparable. Therefore I was expecting social actors to face the same type of problems that Bugey's employees had to cope with.

III-A- Diablo's legacy:

Fortunately or unfortunately, the second and third field-works revealed significant problems with the hypothesis previously taken. Quite naively we embarked on the study of Diablo Canyon, with the more or less implicit prior that we would discover informalities and arrangements analogous to Bugey's pattern. As a matter of fact, to me it appeared that

[25]Obviously the 2 systems differ, the French nuclear Power Plants are all owned by a same public company, the plants are standardized and a lot of their management takes place in Paris. The production of electricity though nuclear facilities account for 80 % of the total consumption. On the contrary in the U.S, 56 utilities are sharing the exploitation of 111 nuclear power plants. Some are PWR, other are BWR, Westinghouse, General Electric, Babcock and Wilcox, and numerous design engineers and architects built the non-nuclear part of these power plants. Not one single plant looks exactly the same, not a single plant have the same set of procedures and guidelines to go by. 20% of the produced electricity is nuclear.

the problems and uncertainties Diablo had to face were even more susceptible to lead to arrangements and informalities:

The time constraints were enormous, aggravated by the specific financial deal, the "rate-case settlement"[26] under which Diablo was allowed to function. PG&E, the utility which owns the plant, was only going to make profits if the units were running. This special agreement between the California Public Utility Commission is rooted in the troubled past of Diablo Canyon, a costly project carrying lots of flaws during the lengthy construction, nearly 20 years, which progressively acquired such a bad reputation that most of the observers forecast that the project will never be a profitable enterprise in the production of electricity. For the signing participants of the rate-case, PG&E had to be heavily penalized if the plant was not able to run at a satisfactory level of availability [set at 58% a common figure for the industry at that time]. Therefore it was decided that, the consumers would not suffer from a bad management of the plant, if the plant was not running, the utility could not charge the consumers, hence, the utility will only be able to make profits if the capacity factor is above 58%. The only way Diablo canyon could become a profitable enterprise was to exceed these 58%: the success is impressive, today the capacity factor is around 85-86% for the 2 units and the plant is giving PG&E large profits. For the organization of Diablo, the challenge has always been to have scheduled outages as short as possible. The revenue value of each of the 2 reactors in full operations at Diablo is $ 2.4 million per day [figure given in LaPorte and Thomas 1991].

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[26]California Public Utilities Commission, decision 88-12-083, PG&E.

Under this type of constraints, "cutting corners" could have been a good strategy, maybe the only one ever possible.

Almost immediately Diablo imposed it self as a dramatic challenge. The informants were found to closely work along the lines of their job descriptions, following the rules they were supposed to, they were mostly working with their subordinates if they had any or with their supervisor. They had no conflict whatsoever or had some in the past but this "bad habit" had long been abandoned, the procedures were not only followed but if one couldn't work with them then a special structure had been created to "expedite things" and up-date them quickly. A deep aversion for informal ways to resolve problems was frequentely stressed by the informants, which wrongly invited me to dig more and insist because to me this aversion for informalities was the very sign of their problematic existence for the social actors involved in an uncomfortable double-binding.

> *"At the beginning people hated it [the Outage Control Center], in most cases it doesn't speed things up...the former way was I know someone in the mechanical maintenance section or in the electrical section and he will fix it for me, but if you don't have a Jo, you don't know who to call. I was only as good as the people I know. Now the job gets done even if I don't know the right people." [Power Production Engineer, Diablo Canyon].*

III-A-a-Consensus as a rule of coordination, no room for any flexibility:

In fact, the organization of Diablo has adapted to this major time constraint by a minute proceduralization of the work, a detailed division of labor, an extensive use of resources and the design of special work-teams responsible for the preparation during 18 months of the all the steps needed to perform any specific job.

The outage control center is not an open structure where everybody is welcome to bring what he wants. The representatives present at the OCC have clear tasks, they are focused on the status they must give every 3 hours to the outage manager. They rely on information given by the foremen and the general foremen from the field. And in order to assure that these information are reliable, the outage manager sends regularly 3 special aides on critical job-sites to double check that the information he has been given by the representatives are accurate. Consistentely, the role of the outage manager is not to find substitutions when delays are threatening the logic of the schedule, but rather his role is to ensure that the schedule is strictly followed. Unlike the Bugey's case, the goal is not so much to increase the efficiency of the schedule but to ensure that the schedule is met. This complete commitment to the schedule can be explained by the amount of efforts devoted to the design and preparation of the outage schedule. A scheduled outage at Diablo occurs every 18 months, its preparation will take 18 months, regularly focused on several milestones. The creation of special task-forces, the High Impact Teams takes care of the organization of the outage in a very interesting way. Once the scope of the work is known to the outage manager, he will divide the work in windows and associate a window with a specific duration to a High Impact Team. About 30 HIT are created for an outage, they can

count up to 25 people, from foremen to engineers, planners and schedulers, even some journeymen. They are loosely managed by a leader, usually a system-engineer, who reports to the outage manager on the progress of the team. Typically a HIT starts meeting a year in advance, and more regularly as the outage's start is closer. The leader has no formal authority over the members of his team, his role is to coordinate them so as to see them making progress on the tough issues they had been given. Usually the window they have to work in is too small, they will have to find ways through a consensus to fit everything in this duration. It can take a year before they reach any kind of consensus, but once they have decided on a game plan, this plan will be severely enforced. This consensus is a key element here and I will give an example to show how this kind of consensus play an important role in the enforcement of the planning agreed[27].

A mechanical General Foreman came one day at the OCC to express the concerns of his foremen regarding the next window. The craft wanted to change the schedule, instead of working the valves one after the other, they wanted to work on each valve at the same time, that way if they were to run into a problem they will be able to direct their attention on another one, and in parallel deal with the problem. They thought it will be quicker. The outage manager took very badly that the general foreman dared express the concerns of the craft, he send him away, arguing that the schedule had to be strictly followed, too bad if somebody had a better idea, he should have voiced his disagreement a long time ago. This incident was taken one step further because the general foreman went to see his

[27]It is also of high interest to realize that the teams members have no power in setting the duration of the window they have been given. The outage manager takes this decision, they will have to work with it.

superior, the mechanical section director, a peer of the outage manager. The director and the outage manager argued a little bit. But the outage manager didn't change his mind and the general foreman not only had to withdraw his objections, but he had to admit in public that the schedule will be strictly followed by his men. The incident struck me because I began to realize that unlike Bugey's way of doing business, where it was understood that the schedule could be changed and modified, Diablo's schedule had a quasi status of law. In a sense no matter if there could be a better way to organize the valves work, there will be no deviation whatsoever. The entire cohesion of the outage was at risk. Interestingly enough most of the observers of the clash between the outage manager and the General Foreman agreed with the outage manager's position. Deviations and last minute good ideas were clearly seen as dangerous because they could blow away the consensual basis of the schedule. Therefore, the schedule is not a perfectible tool, it's a rule of coordination. Yet, the General Foreman aware of this rule, raised the question anyway, so what can explain his audacious move? The HIT process has a terrible time to associate the craft from the beginning. Craft personnel are usually too busy in the shop to have the time to go in HIT meetings, hence they usually joined the HIT in the last phase, which make them less committed to the consensual schedule. One can argue that because of this late attendance, the schedule is less consensual than previously announced. In a sense that's true, but the way the work is detailed and there's so many interdependences and complexity embodied in the way the activities are going to be executed, even if the craft saw it differently, it will be hard for them to execute the work other than scheduled. In addition a bonus is attached to each window for the completion of the work on schedule. There's a clear pressure from the

part of the HIT members on the execution teams. The HIT members have worked on a game plan for more than a year, they are unwilling to see the "logic" as they say destroyed. Therefore for the craft personnel there's little incentive to find a better arrangement, there's only an incentive just to do what's planned and scheduled. The incident between the general foreman and the outage manager had little chance to see a victory from the general foreman's part. This event showed that despite a consensual method of organizing the work, some holes are visible. The work group is also at Diablo a source of uncertainty for the masters of the schedule. One of the reasons which led the outage manager to have 3 special aides who double check the information in the field. This story invites us to make a second point which I believe stresses the difference between Bugey and Diablo: Diablo's schedule took 18 months to be built, Bugey's schedule only 2 months. Therefore the commitment at Bugey is far less important, plus it is clear that the 2 schedules look quite different. Diablo's schedule goes in every detail, most of the coordination processes that will take place are already written up. Bugey's schedule is more of a general guideline. Since a lot of the conflicts in the field had not been foreseen, because of a lack of time, the schedule has to be flexible, in order for the outage manager and the general foremen to play with the substitutions. Bugey's schedule is not as detailed as Diablo's, therefore in order to respond to all the surprises the craft finds in the field, the Structure d'arrêt people must clearly adapt the schedule and make some substitutions and swaps. Bugey's outage would never finish in time if these kinds of arrangements were not possible.

III-A-c-Following the procedures may as well be a good strategy:

More astonishing Diablo's workers follow the procedures during outages, not a single respondant gave evidence of sharing discretion with his colleages regarding the use of procedures.

> *"Here is the responsibility of the technician, if he ever observes any problem like a leak, then he has to contact the foreman and they discuss it. The foreman takes the appropriate measures...usually you write an Action Request to document. The technician is an instrument for the discovery, the rest is beyond his scope of work...in this country, you can't do a job unless it's an emergency that is beyond your scope of work. But if there is a steam, he will shut the valve of course. For normal work if there is a need to deviate from the work-order, they must get approval and besides many of the systems are too complex for them. The technician may not have the whole picture. The foreman will then speak with engineering, the planner and the technician, it's a team effort". [I&C foreman, Diablo Canyon].*

The workers I talked to all stressed that each time they run into a problem they will call their foreman. They would never try to solve anything on their own, because as they say "this is not what's expected from us". Interestingly enough some foremen resent this attitude but in the meantime they see the workers' unwillingness to take any responsibility as a safe element in this organization.

> *"The day of the journeyman is all laid off, he doesn't have to worry about anything. He tells the foreman, 'I'm not management, I'm not required to take any responsibility other than my work-order. The workers aren't under pressure, the foremen are accountable for about everything. There's a lot*

of limitation because of the Unions. They protect them for being responsible. I try to get the workers involved enough so that they get responsible upon themselves and some do. They have to have ownership in their job but they have to volunteer that...They can also reject that. We call it 'malicious compliance'...let me explain that: A child has to eat carrots, meat and potatoes, if you say to him eat your carrots, he will only eat the carrots and not the rest, that's 'malicious compliance'." [I&C foreman, Diablo Canyon].

"Last night we wanted to do something, the ops said no, the technician said O.K, I won't do it because it's the upper management's problem. I am union, I don't have to take initiative..." [I&C General Foreman, Diablo].

"We have restriction for the technician, it's called 'verbatim procedure compliance'. You have good control on what goes on, you probably make less mistakes, plus they are subject to positive discipline, if they don't follow the procedure. But, bottom line it's always, 'you, management you tell me what to do'.." [I&C General Foreman, Diablo Canyon].

By studying carefully the way procedure-problems got solved at Diablo Canyon, it appeared that the workers really had no interest in violating the procedures. It appeared that asking for help with a procedure was not time-consuming at all for a worker. The field had full support from the engineering part in solving any kind of problems they were running into. The number of engineers equals the number of foremen for each section, I&C, Electrical and mechanical. In the mechanical section, 12 section engineers support the crews of 12 foremen, in the electrical section 8 section engineers support the work of 6 foremen and in the I&C department 10 section engineer with the help of 20 procedures writers,

specifically dedicated to the creation and modification of I&C procedures are closely working with 10 foremen. The engineers except for the I&C section, are the one who are responsible for the creation, modification, up-dating of the procedures. During an outage they will act as real foremen in the field to help out and correct on the spot instantaneously what's wrong. The foremen work constantly with the engineers. As soon as something happens in the field, the workers are warning their foremen, who rapidly contact the engineers.

> *"When you are in a gray area, you're not alone. But you know, we both sign on the work orders the engineer and the foreman. We document together, you don't it on your own. You can't say 'I' decided to do that, this is wrong. If it's a real gray area, if you're not sure, you need to get somebody involved in it and the engineers are glad you call them, rather than not...usually it's a pretty good fix." [mechanical Foreman, Diablo Canyon].*

During an outage the engineers are readily available, because most of the time they shared the foremen's offices or more frequently they will be in the field with the workers. Some of them are seeing themselves as "acting foremen", and most of them enjoy this new role.

> *"The engineers?...They are upstairs, <u>they are with us, they are like us</u>...It's a good relationship, they have their priorities, I have mine and sometimes they don't match but that's OK". [Electrical Foreman, Diablo Canyon], [underline is mine]*

It is clear here that those who have the power to change the procedures have also access to the field, and they are in sufficient number to face the

number of problems raised by the craft. They are closer to the field than normally, and they supplement the foremen with the crews.

One of Diablo's puzzle is the complete foremen's absence in the field. Diablo's foremen don't go out in the field, looking over the shoulders of their workers. They are required to be in the field at least 20% of their time, but they confess that they barely comply with this minimum requirement. They explain that they don't want to give the impression that they are here to do a field-police.

> *"I am very little in the field, I don't want to be a field police, it seems to them like you quiz and to my opinion it undermines any trust you had established with your crew" [electrical foreman, Diablo].*

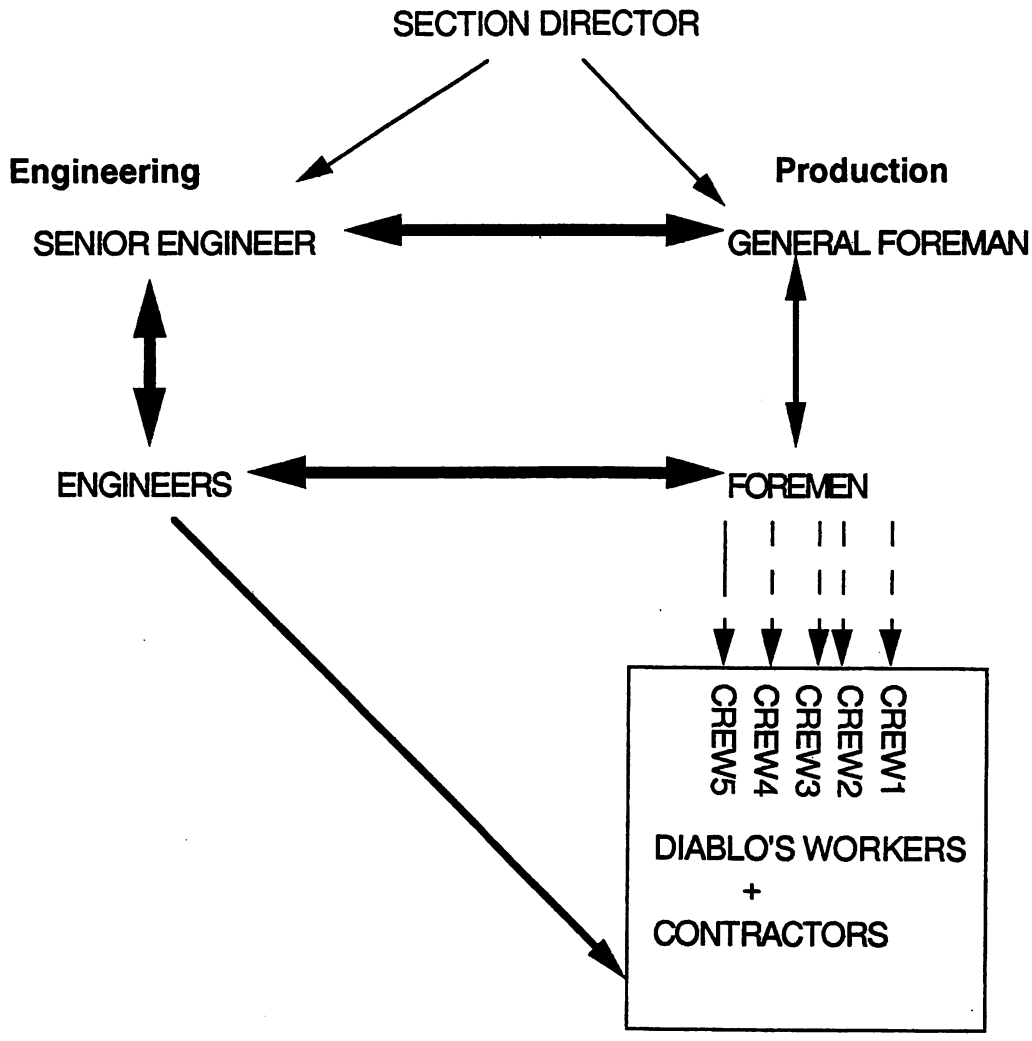
The foremen don't leave their offices, they are constantly talking over the phone, trying to get some help for their workers, but they will not confront the problems in the field. Their relationships with their crews are distant and somehow tense. All the foremen I interviewed stressed the fact that because of the union rule, they are not allowed to use any tool except under emergency conditions. The reason being that workers fear that "it takes away another man's job if a foreman works". It is interesting to see that like any other formal rule, this rule which directs the relationship between workers and their foremen is strictly followed at Diablo. However, the second American plant I studied, North Anna, had the same contract between workers and foremen. Foremen were not supposed to physically do the work with the persons they are supervising. Yet, "acting foremen" at North Anna were no exception, and they were welcome in the

field by their workers, who didn't feel threaten by them. Therefore, the observance of the "union rule" at Diablo had to be explained in the organizational context, which allows workers and foremen to develop distant relationships. The foremen resented that the workers will never take any initiative while performing their job, but in the meantime they seem to appreciate the fact that the workers will never go ahead and proceed if no order had be given. From the workers part, they felt that they had no interest in taking any initiative, because if they did something wrong they will be disciplined, besides they "were not supposed to". The foremen felt frustrated, not because it made their job more difficult but rather because the atmosphere was not a friendly one. They could never count on the workers to go out of their way to help out. They acknowledged the fact having workers applying "the verbatim compliance" precept was reassuring, but in the meantime they also were aware that it took a high toll on the atmosphere and friendliness of the work place

More importantly, the organizational analysis shows that workers adopt a rational strategy by following the procedures. Since they have unlimited access to the engineers, they are not loosing any time in doing so. In addition, since the foremen cannot on their own change the procedures, because it has to be done jointly with the engineers, their necessity on the job-sites is therefore limited. One can argue that the union rule self-reinforced the blunt fact, that foremen do not have the power to change anything on the procedures, which keeps them away from the field, where they have little to offer. On the contrary the engineers can expedite a number of things. Since both, the foreman and the engineer must sign any change, they work as a team. The union rule, which prevent foremen from working with tools, is like any other rule subject to compliance or not. It

seems that at Diablo, this rule is strictly followed, because the foremen are of no direct use in the field. Since they don't have the formal power to change anything on the procedures, they have little to offer in the field, apart from a close supervision, with in that case will not be counterbalanced by a real help, and thus resented by the workers.

This last example has shown that procedures are followed at Diablo, because the workers have no interest in doing differently. If they fail to do so they can be disciplined but more clearly since they can reach out to the people that can help them out in a timely fashion, why should they go to the expense and trouble of cheating. In order to ensure that procedures get followed, the organization has enormous resources to provide an equivalent number of foremen and engineers for each section. The key here to understand why these procedures get followed is to study the process of changing a procedure. At Bugey, the craft had no way to get a procedure fixed, therefore only big problems will surfaced and be brought to the attention of the "préparateurs". Bugey's workers arrange themselves with these inaccurate or incomplete procedures, they obey to a self-imposed censorship, which regulates the deviations they practice. They have no alternative because they have no power and no means to get things fixed.



Diablo's relationships in the field

III-C The craft empowered: North Anna's pattern

The third case, North Anna, led us to consider what happens in an organization where the power to change the rules is given to the craft. This is a third model of dealing with the complexity and uncertainty of having to work with detailed procedures, while so many unplanned events and so many surprises can happen in the field. North Anna has in common with Diablo Canyon that the procedures are strictly followed by the workers.

North Anna Power station displays a completely different organization: roughly 1000 employees are working on site. There is no real "structure d'arrêt", or "Outage Control Center" but a rather light coordination office staffed with a couple of coordinators, an outage coordinator and his planner and scheduler. As a matter of fact, one can observe that the outage period doesn't call for a different treatment of events.

> *"We really try not to change the way we're doing business between non-outage time and outage." [Outage manager and superintendant planning and scheduling, North Anna].*

A combination of an extreme centralization of the decisions in the hands of the 3 upper-management representers, the station manager and his 2 assistants, and in the meantime the empowerment of the craft, on the maintenance side and on the operations side, allow the organization to be responsive enough in the event of an outage. Unlike Diablo Canyon, the utility that owns North Anna has less financial means, the resources that the plant personnel can use are less abundant. For example, the planning and

scheduling department, which counted 100 persons at Diablo, has only 36 employees, the maintenance department at Diablo kept busy 400 persons, only 250 persons work at North Anna.

But what is really striking is the amount of responsibilities left in the hands of the craft. Since 1989, workers are certified [through INPO] to become level II quality inspector. Each morning, each foreman will designate among the members of his crew, which worker is going to be the quality inspector for the day. As soon as the day starts, the designated craftsman will not work any more under the supervision of his foreman, if he sees something suspicious he will report it to the quality control supervisors. The workers have all [nearly all] attended a series of classes paid by the company in order to become certified level II inspectors. The NRC agreed on this program even though at first its inspectors were reluctant to let the verification of jobs in the control of the craft people themselves. Most of the workers like the system a lot, they loose less time and feel better about the fact that somebody who knows exactly the job will inspect it.

> *"What was happening was that I will start to do some work, there will be a 'hold point' [on the procedure], meaning I can work up until that point and then I will have to stop, maybe there is only 1 or 2 inspectors covering 7 jobs so there was a lot of delays...What we said is that now when the man is doing a Q.C verification, he works for Q.C and he doesn't work for maintenance, if he has a problem he tells Q.C because the person that does this job must be independent. At first one crew with one foreman went through the program done by Q.C, they have a week of training, a required list of readings, a team building session and a proficiency". [Quality Maintenance teams coordinator].*

[How do you feel about the Q.C program?] I like it, I really take pride in it. I am very environmentally conscious, I fell good about it and I tell you what, there is no way that bad work can be hidden from me". [mechanic, Tom].

Regarding the use of the procedures in the field, a third model is at work. Unlike Diablo, where planners and engineers are devoted to help out the foremen and their crews, and unlike Bugey, where the préparateurs, the ones who wrote the procedures and who have the authority to modify them and the engineers are nowhere to be found in the field, at North Anna the foremen can initiate a change, add some supplemental work instructions, if they feel that their workers need some more guidance. But first, one has to mention that the foremen are really responsible for the preparation of the work-packages. Once the work-order is issued by the planners, there is still a lot of work to do before an activity can be carried out in the field. At North Anna the classic work-order tells only the location of the problem, a brief description of the problem, the parts associated with the components -which the planner has ordered at the warehouse- a radio-protection permit if needed, plus the number of the procedures applying When the foreman get the work-order on his desk, he still has a lot of work to do. He has to study the procedures, make sure they are current, he has to look in the technical manual or the vendor manual, he will walk down the job-site, see if a clearance has been correctly asked to the tagging persons. Then, he will ask his workers to take a look at it and if it's something unusual he will probably write down a couple of more detailed instructions. If it appears that the procedure is inaccurate, or incomplete, the foreman can initiate a change, he will ask some advice to the engineering group and to the Q.C supervisors in order to be able to build a

case. In many instances, his craftsmen will help him, writing up some of the phases they want to see changed. Once his demand is documented, he will have to present his request of change to a special committee, the Station Nuclear Safety and Operations Committee, where most of the superintendants seat. The members of this committee will decide whether his request sounds correct and justified and if the future change is in compliance with the technical specifications of the plant.

> *"We have a procedure, we are expected to follow it exactly...But it's easy to come to a point where it doesn't work...but we have to follow...a failure to follow and you're in big trouble, so <u>we need to change it</u>..."[mechanic, North Anna, underline are mine].*

> *"We can initiated a change, we identify what change, we write the correct steps and then, the foreman he will take those to engineering, they'll approve it and put additional info and then Q.C will review it and approve probably and then the foreman will carry it to the SNSOC...I have a mixed opinion on SNSOC, some of the station managers seem to be very interested, some just sign, they are responsible for approving but most of the time they put their faith in engineering, you have very knowledgeable station managers, there's always the possibility that it can be refused". [mechanic, North Anna].*

Foremen and workers are sharing the preparation of the work: they are not only sharing the actual performance of the job, since foremen are often seen helping their subordinates in the field, they also work as a team, when the work group wants some changes in the way the work is going to be carried out. The fact that foremen have to rely heavily on their workers if they want to face all the requirements of their jobs, especially regarding

the preparation of the work, has established close relationships between workers and their foremen.

> *"We have to study company policies, I feel that the foreman has an unfair amount of responsibility, ultimately, they seem to be responsible for every thing to me...all the different things that go with the work-packages...the planning department publishes work-orders, but the responsibility for making sure that the correct procedure is used, and the acquisition of special tool...evrything is up to the foreman...any problem with the procedure is his responsibility to have it solved...we are just trying to help to cover all the ground, we'll review procedures, technical manuals, we help our foreman...I don't understand a management that puts so many responsibility on the lower level...the foreman, he used to be just like me you know, we all work together."[mechanic, North Anna, underline are mine]*

They are sharing the same drama and are involved similarly when their foreman has to present in front of the SNSOC committee what they think, as a team, could be an improvement.

> *"They are nervous, they are afraid they get rejected, today you haven't seen anybody rejected, we don't criticize them personally, we want sound presentations." [Assistant station manager, Chairman SNSOC].*

This mechanism shows that the foremen and the workers have both means and power to change the procedures if they judge that they cannot safely and correctly work with them. They don't need to go ahead and informally make the changes they think are necessary, like in the Bugey's case, they don't call the engineers to take responsibility with them and partly for them like in the Diablo's case, they are actually part of the

solution. The fact that they are the ones who must present the request at the SNSOC Committee make them responsible for their demands.
Once the changes are accepted, they will be up-dated by the procedures group writers, and the foremen will get a copy to review it.

Conclusion: informalities and arrangements are not always key dimensions in organizational life:

It is certainly not always in the interest of the work group not to follow the rules, because the action "following the rule" is not only function of the strategies that social actors develop in order to do their jobs, it is also highly dependent on the structure the social actors are in. Therefore Terssac's model, is highly dependent on the fact that the execution's group has no power in changing the rules, that there is no possibility for them to ask or initiate an up-date of the rules because the group susceptible to do it is absent from the field.
In fact, Terssac never seems to realize that procedures can be changed at all. It seems to me that the implicit deal between the work group and the management and their respective strategies described in Terssac's book are based on specific conditions regarding the creation, the modification, and the role of the rules in particular organizations, i.e French Nuclear Power Plants [(a) rules designed outside the execution's group, (b) imposed on the execution's group to influence its behavior, (c) and meant to be respected, (d) Apparently non-modifiable]. While most of this specifications are largely admissible, two of the conditions which supports Terssac's theory are not present in the 2 American cases: (1) Procedures are not always designed outside the work group. In fact North Anna is a clear example of an organization where the possibility of creating, up-dating and modifying

procedures has been given to the people who actually perform the jobs. Which doesn't mean that they are on their own, they can ask for some advice to the engineers or to the QC inspectors. (2) More importantly, procedures can be changed and up-dated, Terssac never deals with this possibility in his theory, which tells us probably more on the way the work is organized in French Nuclear Power Plants [production and enginiering largely stranger to each other] than on the way workers in general deal with highly complex tasks largely constrained by a huge number of procedures they have to go by.

These 2 omissions question the generalization of Terssac's model and probably restrict his theory's application to the French case, which he did not intend to.

The results of this research show that:

1) The workers will have to violate the procedures if they do not have any formal control on their modification or up-dating.

2) Their discretion over work processes will then be increased, leading to a great uncertainty on how to monitor them.

3) Hopefully, the system works by a set of tacit rules, shared among the work group and their immediate supervisors, because if workers went too far in their violations they could be in trouble, alerting their management which will result in a decrease of their power, hence autonomy, if one wants to use Terssac's word.

<u>On the contrary</u>

1) If workers have formal power over the modification and up-dating of procedures or direct access to actors formally able to change the scope of the work, change certain steps of the procedures, or write on the spot a

new procedure designed specifically to deal with unforeseen situations, their willingness to comply with the rules will be increased.

2) It would be less costly for them to initiate a change, because they have control over the procedure of change.

3) This doesn't mean that they can do whatever change they want, but rather that they can ask for whatever change they need.

4) Subsequently in an organization which provides the work group with formal discretion over the rules, one can also expect the process to be controlled for balance, in the same way as when workers use their entire discretion on changes that have to be made on procedures, which will not be incorporated and therefore are driven by a sense of measure in these violations, the work group who can initiate relatively easily changes on procedures is expected to have reasonable demands and stand strongly behind these changes, i.e rapidly digesting the new changes.. Workers are expected to follow the rules in the 2 cases, if they believe they can't they have the means to change it, if they believe the procedure can be worked that way, then they have to follow it step by step.

Our empirical evidence has clearly showed that the degree to which informalities play a key role in organizational life can vary depending on the organization we are looking at.. Informalities, arrangements and bricolages do not automatically emerged from the cooperation of social actors. Our study shows that there is a high correlation between the formal discretion that social actors have on rules and procedures they are supposed to obey, especially in the up-dating process and their inclination to comply with these rules. Informalities are not a given, they are in fact a product of certain ways of organizing activities between management and work

groups[28]. Informalities are certainly not a generic property of all organizations as Friedberg [1993] and Terssac [1992] seem to argue . Uncertainties and surprises in the field will always be part of the workers life, yet being able to change the procedures when they don't match is crucial in organizations where compliance is the only way to stay in business. The key in understanding the reasons why actors follow or do not follow procedures at work is to be able to uncover the actual possibilities they have in order to comply with the rules. Compliance is as much a strategy as informalities are. More importantly there is a difference between observing a pattern of arrangement in bureaucracies and namely in french bureaucracy and claiming that all organizations no matter what they are, are expected to display informalities.

[28]I am at this point much closer to the definition of Crozier [1964], who has shown the importance of informal relations in the specific case of 2 French bureaucratic agencies. In the bureaucratic phenomenon he doesn't seem to generalize to all organizations.

Technical appendix:

The type of nuclear power plants we choose to study are all Pressurized Water Reactors [PWR], two 3 loops [Bugey, North Anna] and one four loops [Diablo Canyon], ranging from 900Mgw/per unit to 1100Mgw/per unit. 3 scheduled outages occured at the time of the 3 field-works. I went through the training and testing to be cleared for "unescorted access" to the secure areas of the 2 American plants.
I also visited the Nuclear Regulatory Commission in Washington, where I did 15 interviews to better understand the regulatory setting in the U.S.

Number of interviews at Bugey: 65, distributed as follows.[Station Manager (1) ops engineers (2), shiftsupervsiors (3), assistants shiftsupervisors (4), outage manager (1), assistant outage manager (1), engineers (5), General Foremen (10), Foremen (6), Préparateurs (3), Contrôleurs (5), technicians (2), Sec-Radio-Protection (2), Contractors engineers (2), contractors foremen (6), contractors technicians (3), various other EdF groups (7), Quality Control (3)].

Number of interviews at Diablo Canyon: 90, distributed as follows [Journeymen (7), Foremen (12), General Foremen (7), Section Directors (7), outage manager +staff (9), Engineers (10), Planners (9), Schedulers (8), Administrative personnel (5), Quality Inspectors (9), Opeartors (4), NRC resident inspector (1)].

Number of interviews at North Anna: 70, distributed as follows.[craftsmen (8), Foremen (9), General Foremen (8), Ops personnel (8), 4 shiftsupervisors included, Nuclear safety (9), engineers (7), upper-management=station manager + 2 assistants (3), Superintendants (5), Planners and schedulers (10), NRC inspectors-residents (2)].

I used a same semi-structured guide for the 3 cases:
(1) The first set of questions is aiming at understanding the work performed by the interviewee [description of the work, various difficulties, problems to face. The way he or she tackles them, interest in the job. List of the typical activities performed in a day, or in a week].

(2) The second set of questions investigate the work-relationships, their importance, their intensity, their frequency, their goals.
(3) The third series of questions is usually more open. It is often based on very actual problems or reform that workers face at the time of the field-work
(4) At the end of the interview, I asked a couple of biographic questions to the person interviewed [training, age, seniority, expectations, prospects of career].

In addition, I was allowed to observe a number of managerial meetings and supervisory meetings: [outage Up-date meetings, Self-managed teams meetings, plant meetings, foremen's briefing, maintenance department's meetings, operations's department meetings...].

I was also able to follow certain activities in the field, in particular quality inspection activities.

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