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PICKERING NGS-A versus PICKERING NGS-B

Changes in Commissioning Techniques and their Impact

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Synopsis

Modernization of equipment, changes in design codes and standards, tightening of regulatory requirements have combined to make Pickering NGS-B in many ways different from its predecessor, Pickering 'A'.

This paper briefly describes how a few selected commissioning techniques used to place Pickering 'A' into service were further developed to cope with the new requirements for Pickering 'B'.

The relative performance of the commissioning programmes between the two stations is also compared.

1.0 Pickering 'A' Program

In 1964 Ontario Hydro committed a four unit (540 MWe gross/unit) "Candu" Nuclear Generating Station to be located on the shores of Lake Ontario at Pickering just east of Toronto.

Fig. #1 shows an aeriel view of this generating station taken on its completion in 1972.

The first Unit was originally scheduled to go into operation in 1970. The future of the Canadian Candu Nuclear Program and the Ontario Hydro power generation program depended very heavily on the success of this project. It had to work and it had to perform well. Commissioning had to be done fast and efficiently and the emphasis was placed very heavily on production.

By 1969 commissioning was well underway and the first unit was scheduled to go critical on January 1, 1971.

Certain 'Commissioning Criteria' had been employed by Ontario Hydro's Nuclear Generation Division in the past and were adopted for the commissioning of this big new adventurous project.

Fig. #2 lists these criteria:-

- Commissioning was to be performed round-the-clock by the people who would eventually run the plant.
- Duplication of effort between commissioning and construction was to be kept to a minimum, reliance was to be placed on construction quality.
- Safety systems would be checked and tested and whatever failed would be fixed.
- Process systems would be switched on and fixed if they failed.
- Documentation was according to the standards of the day, ie, reports emphasized problems encountered rather than documenting acceptable performance.

The performance of that commissioning program was exceptionally good!

Fig. #3 illustrates that performance.

The first unit achieved criticality on February 25, 1971 (only 2 months late) and achieved full power operation only 3 months later.

The fourth unit achieved criticality on May 16, 1973 and achieved full power only 12 days later.

In 1973 the station capacity factor was 84%.

It Worked and It Worked Extremely Well!

The commissioning process was therefore to be followed, as closely as possible, for commissioning Pickering 'B'.

2.0 Pickering 'B' Development

In 1974 a new station was committed which was to be, as far as possible, a "repeat" of the very successful Pickering 'A'. In an attempt to capitalize on the existing manpower, organization and facilities the new station was to be built onto the existing plant.

The first unit was scheduled to go in service in March, 1980 with the last scheduled for April, 1982.

As design progressed the original mandate that the two stations should be identical was found to be impractical. Technology, safety codes and equipment designs had changed over the last 10 years. Substantial differences therefore developed between the two designs.

In 1978 a major problem was discovered with the boilers which it was estimated, would take 2 years to repair.

In 1979 the Three Mile Island incident occurred which opened the eyes and ears of the media and public to the "so called" hazards of nuclear power.

The regulators and design analysts took a new and more rigorous look at the design. The designers developed new analysis techniques, such as safety design matrices, to answer the questions of the regulators. The outcome was a "paper chain reaction" and a profusion of new systems and an increase in the complexity of the old systems.

Fig. #4 shows a comparison of the amount of design licensing paper required to get Pickering 'B' design licensed compared to Pickering 'A' and Bruce 'A' and its still growing!!!

2.1 Safety Analysis Repercussions

Fig. #5 illustrates some of the increases in complexity that developed from this analysis. Many systems originally classed as process systems on Pickering 'A' became Safety related on 'B'.

As a result Pickering 'B' ended up with 64 systems designated "safety related".

It was no longer acceptable just to switch such systems on. Their safety related functions had to be defined in terms that could be demonstrated during commissioning.

To keep this simple a set of Detailed Commissioning Specifications were produced for each system (See Fig. #6).

These simply converted the design specification, which encompassed all the safety analysis requirements, into something which could be easily and safely measured during commissioning.

These documents were reviewed and accepted by design and supplied to AECB. This ensured a good mutual understanding of what the system was to achieve in terms of performance during commissioning.

Completion assurance and reporting was made easy since it only required a statement to the effect that a system had been tested to the extent that it had achieved its commissioning specifications.

The new analysis and SDM's included many more statements on how to operate the equipment and systems in order to stay within the safety analysis assumptions.

A very rigorous upgrade program was therefore developed which systematically included all the new operational assumptions in the operating procedures. These manuals were then all reviewed and accepted by design for compliance with safety analysis.

2.2 Organization and Planning

By mid-1980 repair of the first set of Pickering 'B' boilers was almost complete. The first unit was scheduled for first Critical on October 1, 1982 and In-Service by April 1, 1983. The last unit going into service some 17 months later in August 1984.

This was, in fact, a more ambitious schedule than was achieved on Pickering 'A'.

The commissioning process used on Pickering 'A' had been extremely successful and therefore was followed as closely as possible.

Round-the-clock commissioning by the people who would eventually run the plant was adopted for Pickering 'B'.

Pickering 'A' was however an operational station which could have conflicting priorities with commissioning Pickering 'B'.

In addition staff from 'A' could NOT operate 'B' without retraining, due to the considerable system differences.

The resolution was a separate technical and production organization with staff dedicated to Pickering 'B'.

Fig. #7 shows the organization adopted to handle placing Pickering 'B' in-service while continuing to operate Pickering 'A'.

Eventually, when all 'B' units are in-service, the organization will resume its original pattern. The commissioning staff being absorbed into the technical and production sections.

The very compressed commissioning schedule (4 units to be placed in service within 17 months) forced a rethink of our planning process.

Our true and tried method of issuing manually compiled daily work programmes to the shift was maintained. In addition a computerized network planning program named PREMIS was adopted. This allowed us to manpower level and activity coordinate on a multi-project basis. Using an adaptation of this we were able to monitor and plan the installation of engineering changes, of which there are 1400 to date.

This program is really proving worthwhile and we are adopting it for Pickering 'A' outage planning.

2.3 Quality Assurance

The Quality Assurance program was introduced to the project as a license requirement during the boiler delay. (J.T. Wieckowski is going to talk later today on that topic).

We already had what we considered a quality process, the problem was to provide documentary verification of our quality. We did not want to change our basic way of operating because it was successful. Q.A. was therefore incorporated into our already existing processes rather than having it imposed on top.

The individual remained responsible for the quality of his work. The line supervisor being responsible for ensuring the individual had the capability and skills required to achieve the desired quality. This has always been our approach for our personnel, radiation and conventional, safety programmes and has been extremely successful.

The Quality Assurance requirements however did take some flexibility out of the commissioning process by proceduralizing everything and demanding documented evidence of quality checks.

On the positive side all our extremely stringent public safety system performance targets have been achieved and we can prove it.

Quality Assurance has helped supply the management tools to assure that we do things right.

2.4 Completion Assurance

In order to assure ourselves and the regulatory authoritities that systems were completed to a state capable of supporting safe unit operation in compliance with the safety report, a series of system by system formalized Available For Service (AFS) review meetings were developed.

These meetings, which reviewed everything from operational documentation through compliance with commissioning specifications to outstanding deficiencies, were run by the responsible engineer. They were attended by AECB, Design, Q.A., and Commissioning Manager. Each meeting culminated in a list of outstanding items for each system which needed resolution before a defined commissioning phase. These lists were put on computer file and as each item was resolved its impediment for the commissioning phase in question was removed.

Fig.#8 illustrates the printout format which actually indicates the stage of commissioning that the system is capable of supporting.

With the help of such meetings adequate completion assurance was available before the commissioning reports were written.

2.5 Scrutiny by Regulators

To comply with the increased scrutiny being applied by the regulatory authority:

Design had provided mountains of analysis,

Construction had provided vaults of history dockets,

Operations did not want to provide anymore paper!!!

Our Quality Assurance Program looked after the commissioning process.

Completion assurance was satisfied by the series of review meetings described earlier.

Basic operational compliance with AECB requirements and responding to their concerns during all the commissioning phases was handled with regular formal meetings between our senior commissioning staff and the AECB site staff.

All our commissioning phase licenses, (there were 8, in all, for Unit 5 up to 100% F.P.) were received in sufficient time that no progress was actually held up due to lack of a license. There were some very frantic days and weekends and many manhours spent in documentation preparation and negotiation and discussion but no actual delays.

However the manhours spent on this licensing effort detracted from our field efforts.

The personnel licensing situation was a similar story. The differences between Pickering 'A' and 'B' made it necessary to have dedicated operating personnel for each plant and AECB license examinations were specific to each.

18 months before Unit 5 scheduled criticality, our first attempt at qualifying our shift supervisory personnel through the AECB examinations showed that the old Pickering 'A' approach, which emphasized field experience along with training courses, was not going to work.

Out of 8 shift supervisor candidates, all of who had been previously licensed, only 2 obtained clear passes.

As a result our training program was stepped up and valuable people were taken from the field and put in the classroom.

Sufficient personnel licenses were obtained to meet our Unit 5 requirements but only just. Meeting the requirements for Units 6, 7 and 8 could be equally as difficult.

The added license documentation requirements and the very exacting personnel examination standards has invoked a very marked move away from field work and experience, into the world of paper and desk training. This has had a noticeable detrimental effect on progress of the commissioning program.

Considerable effort is being directed to develop our training capability to minimize classroom time and streamline the license documentation requirements to ensure less time is spent in documentation for documentation sake.

2.5 Public Awareness

Fig. #9 illustrates the close proximity of our plant to the general public.

This coupled with the increased media interest caused us to develop a proactive, as opposed to just reactive, media relations program. For example, the Pickering steam reject valves exhaust to atmosphere, creating large voluminous clouds of steam over the station which attracts the attention of the local populous. The local media was therefore used to let people know we would be creating this steam during commissioning and that it is perfectly harmless. Our local media sessions have proved worthwhile, and we have received good and bad press for our efforts. The increased susceptibility of the nuclear industry to bad press is even more reason to ensure we can prove we do things right.

3.0 Progress of Pickering 'B'

Pre-critical performance on Unit 5 was excellent and our October 1982 criticality was achieved

Fig. #10 depicts Unit 5 post critical performance compared to Unit 1 and other recent CANDU's.

It took us 5 months from Criticality to 100% Full Power.

Turbine generator equipment problems accounted for the major program delays. The reactor performance was generally good.

Fig. #11, shows the comparison of site operations' manpower used for precritical commissioning of Pickering 'A', Bruce 'A' and Pickering 'B'. Comparing the area under the curves shows that Pickering 'B' has required approximately 12% more site man-hours in the precritical period than Pickering 'A'.

Figure #12 shows the comparative programmes for Units 6, 7 and 8. We are attempting to put 4 units in-service within 2 years and I am confident these future units will do better as we further refine our commissioning processes. Especially the new techniques which helped us adapt the successful Pickering 'A' commissioning process to the new requirements of the 1980's.

LIST OF FIGURES

FIG. 1 Aerial view of Pickering 'A'

FIG. 2 Pickering 'A' Commissioning Criteria

FIG. 3 Pickering 'A' Commissioning Performance

FIG. 4 Design license documentation comparison Pickering 'A', Bruce 'A' - Pickering 'B'

FIG. 5 Examples of Increased Complexity

FIG. 6 Detailed Commissioning Specification

FIG. 7 Station Organization Pickering 'A'-'B'

FIG. 8 AFS Review Printout

FIG. 9 Aerial view of Pickering 'A'-'B'

FIG. 10 Station Progress to full Power

FIG. 11 Commissioning Manpower Comparison

FIG. 12 Comparative programmes

FIGURE #1

AERIAL VIEW OF PICKERING 'A' ON ITS COMPLETION IN 1972

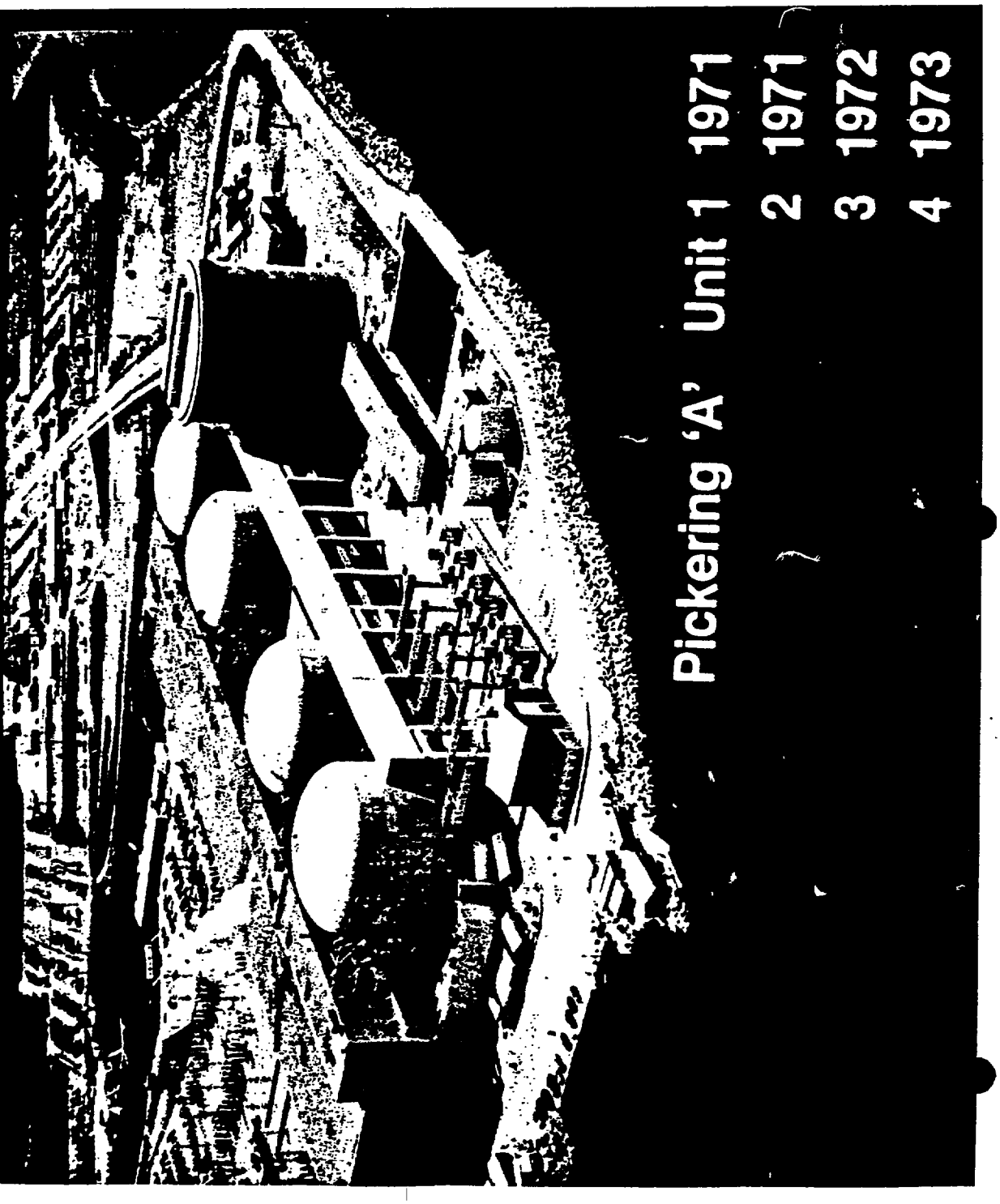


FIGURE #2

PICKERING 'A' COMMISSIONING CRITERIA

- Commissioning Round-the-Clock by the same staff who would eventually run the plant.
- Minimum Duplication of Effort, reliance on construction quality.
- Safety Systems would be checked, tested and fixed.
- Process systems would be switched on and fixed if they failed.
- Documentation was according to the standards of the day, ie, Reports emphasized problems encountered rather than documenting acceptable performance.

PICKERING COMMISSIONING SCHEDULE

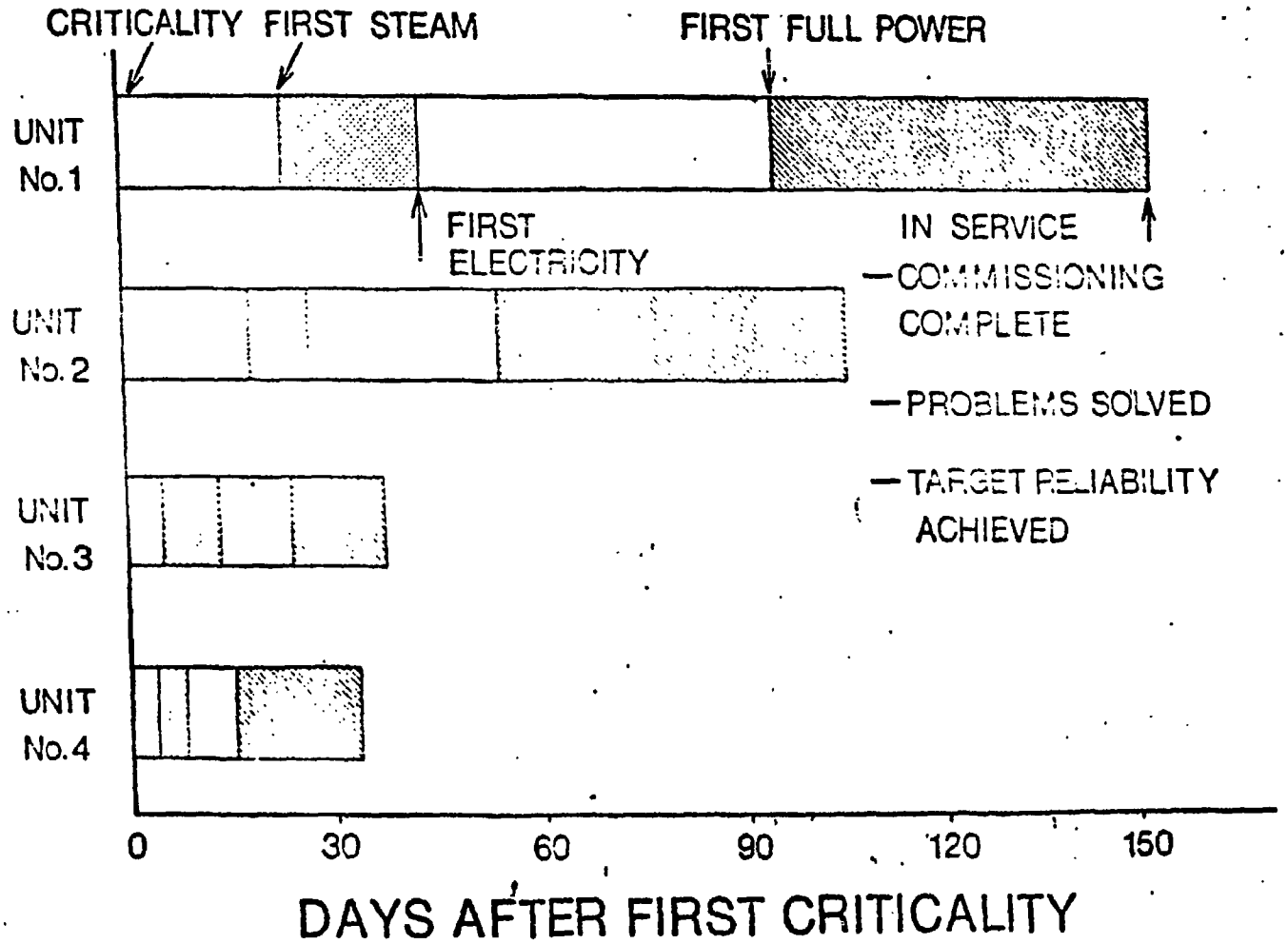


FIGURE 3

FIGURE #4

COMPARISON OF DESIGN LICENSING DOCUMENTATION

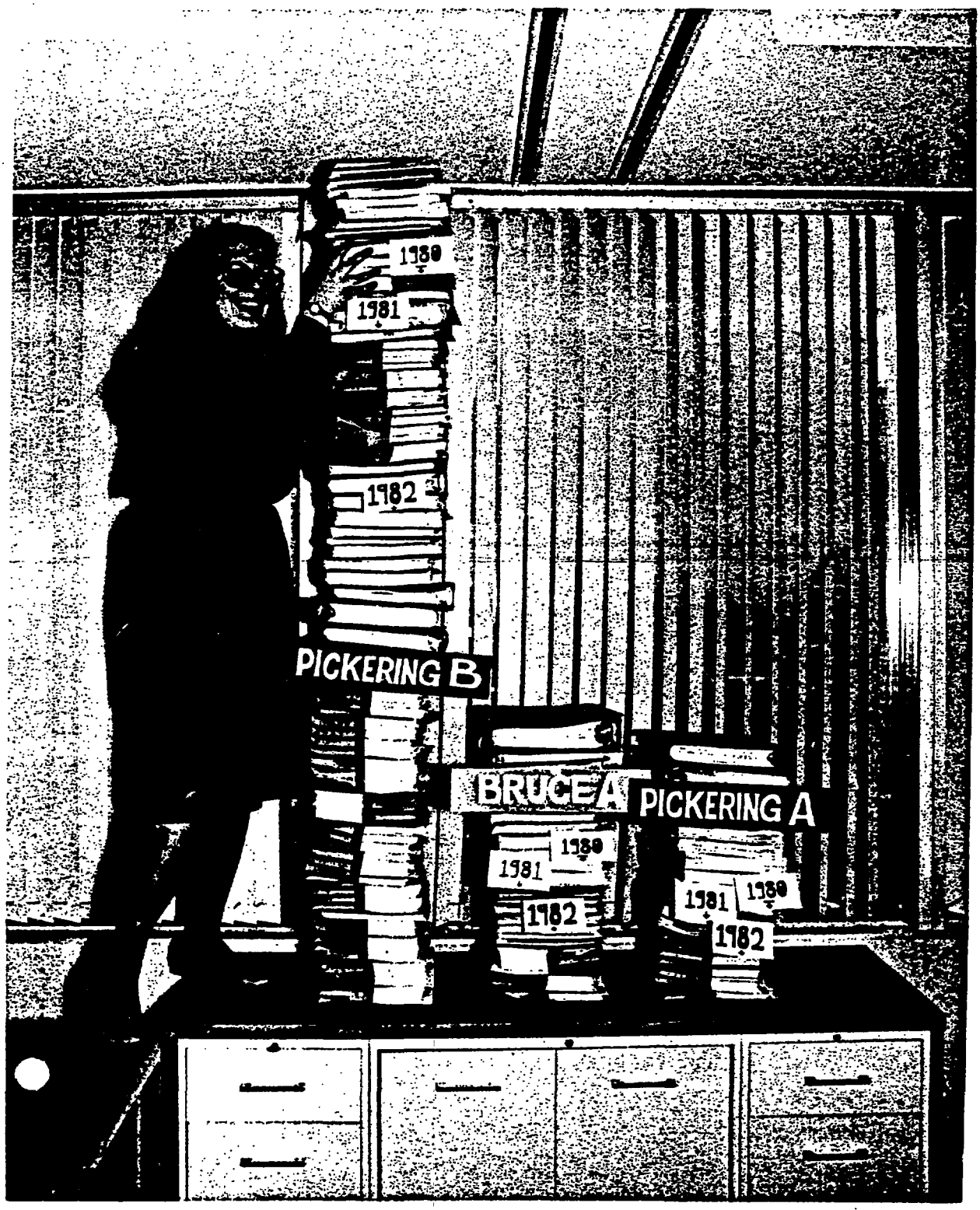


FIGURE #5

EXAMPLES OF INCREASED COMPLEXITY PICKERING 'A' - 'B'

	PICKERING 'A'	PICKERING 'B'
REACTOR TRIP PARAMETERS	9	22
REACTOR TRIP DETECTORS	42	207
SHUT-OFF RODS	11	28 + 4 CONTROL ABSOBERS
EMERGENCY CONTROL ROOM	0	1 PER UNIT
EMERGENCY POWER (SEISMIC)	0	2 GENERATORS & DISTRIBUTION
EMERGENCY WATER (SEISMIC)	0	HIGH & LOW PRESS.
SEISMIC QUALIFICATION	NATIONAL BUILDING CODE	SEISMIC STANDARDS USED THROUGHOUT
ROUTINE TEST PROCEDURES FOR SAFETY SYSTEM TESTING	32 (1971) 92 (1982)	186

FIGURE #6

Detailed Commissioning Specifications

Converts the system design specification, encompassing safety analysis requirements, into something which is easily and safely measured during commissioning.

FIGURE #7

Pickering Organization for Operating Plant 'A' While Commissioning Plant 'B'

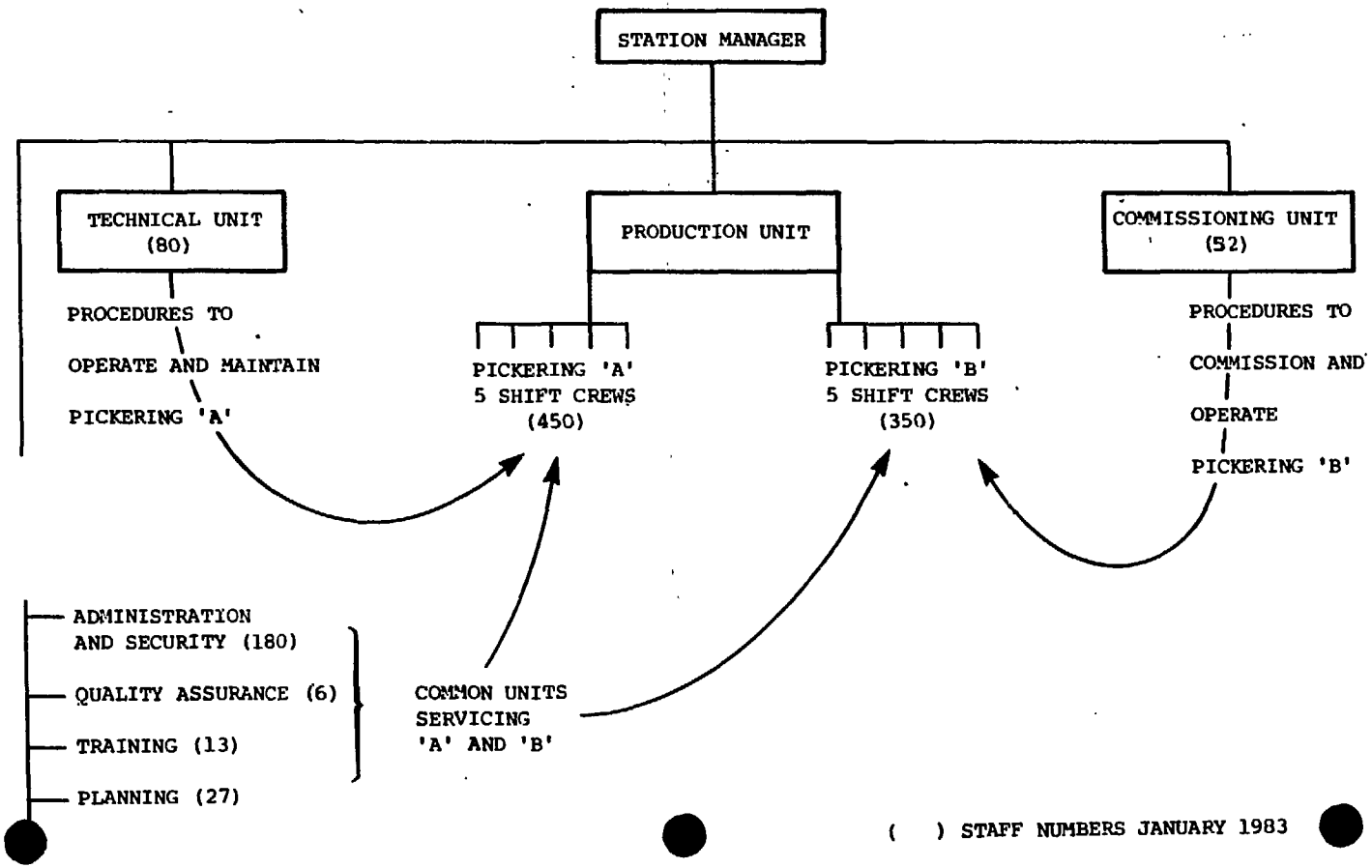


FIGURE #8

Completion Assurance (AFS) printout for Heat Transport System

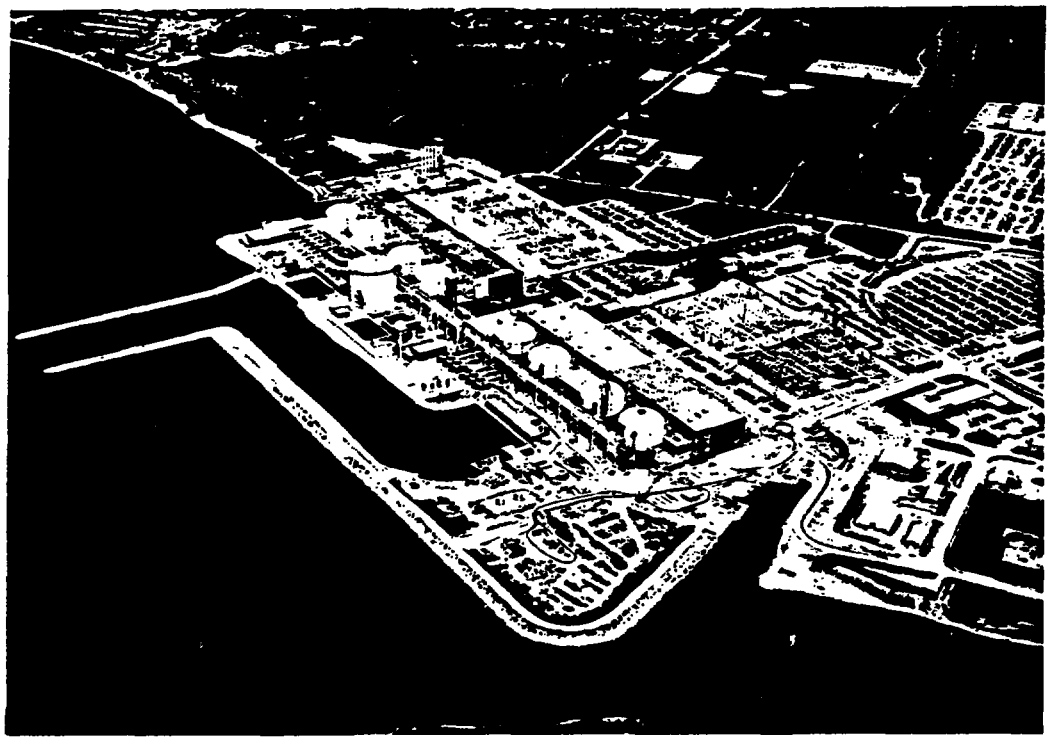
SYSTEM AVAILABLE FOR SERVICE REPORT

		EXCEPTIONS		
	REVIEW DESCRIPTION	SCHEDULE	ACTUAL	READY FOR
33000 HEAT TRANSPORT SYSTEM	DO ADDNL PRESS CRNTL COMM	820915	821015	2-FIRST CRITICAL
	RSLV DR'S APP'C' SECT 7	820915	821007	2-FIRST CRITICAL
	RSLV GLAND SUPP/TEST CCT DR	820915	821018	2-FIRST CRTICIAL
	ISS HYDROSTATIC TEST REPORT	820915	821006	2-FIRST CRITICAL
	IDENTIFY ROUTINE TESTS	820915	821006	2-FIRST CRITICAL
	IDENTIFY CALL-UPS	820915	821006	2-FIRST CRITICAL
	COMM LOCA OVERRIDE BLEED V	820915	821006	2-FIRST CRITICAL
	RAISE EWR TO PICK ENG	820720	820803	1-FUEL LOADING
	CNFRM P TEST CCT CORR ACTN	820728	820803	1-FUEL LOADING
	RELOCATE GFP TBNG-I/S INSPN	820915	821006	2-FIRST CRITICAL
	REVIEW 3300.4A OF DCS	830401		B-IN SERVICE
	CONFRM PURIFICATION CAPABIL	821015		3-FIRST STEAM
	RESLV RV OPENING TIMES	820915	821006	2-FIRST CRITICAL
	REVIEW JUMPER RECORDS	820820	821006	2-FIRST CRITICAL
	REVIEW OF MEMOS	820820	821006	2-FIRST CRITICAL
	CLIV PWR FAILURE TEST	821015		3-FIRST STEAM
	MDFY BLEED FR CONNECTIONS	830401		B-IN SERVICE
	BALANCE 3331-PM1	820915	821006	2-FIRST CRITICAL
	REVIEW CH & FDR HARDWARE	820810	821007	2-FIRST CRITICAL
	CONFRM RESIN SLURRY CAPABIL	820915	821007	2-FIRST CRITICAL
	ISSUE OP MEMO-D_2O LOADING	820823	821006	3-FIRST STEAM
	PRFM THERMOSYPHONING TESTS	830401		B-IN SERVICE
	ISSUE R-1 OP MANUAL	821101		3-FIRST STEAM
	ISSUE OP MEMO D_2O LOADING	820823	021006	2-FIRST CRITICAL
	OP&P OM SECTIONS TO AECB	820813	820813	1-FUEL LOADING
	L.O.P. FRM AIM TO R. LIOR	820815	820730	1-FUEL LOADING
	CHK WCA FLOWSHEETS OK	820816	820820	1-FUEL LOADING
	ISSUE AFS MEMO	820915	821007	2-FIRST CRITICAL
	ISSUE ACTION ITEM LIST	820823	820816	1-FUEL LOADING
	ISSUE COMM REPORTS	830401		B-IN SERVICE
	PRFRM HOT SWITCHING TEST	830401		B-IN SERVICE
	PRFM CRASH COOLING TESTS	830401		B-IN SERVICE
	SEISMIC QUALIFICATIONS	820915	821007	2-FIRST CRITICAL

SYSTEM 3300 READY FOR FIRST CRITICAL

FIGURE #9

AERIAL VIEW OF 8 UNITS - PICKERING NGS



STATION PROGRESS TO FULL POWER

Fig.10

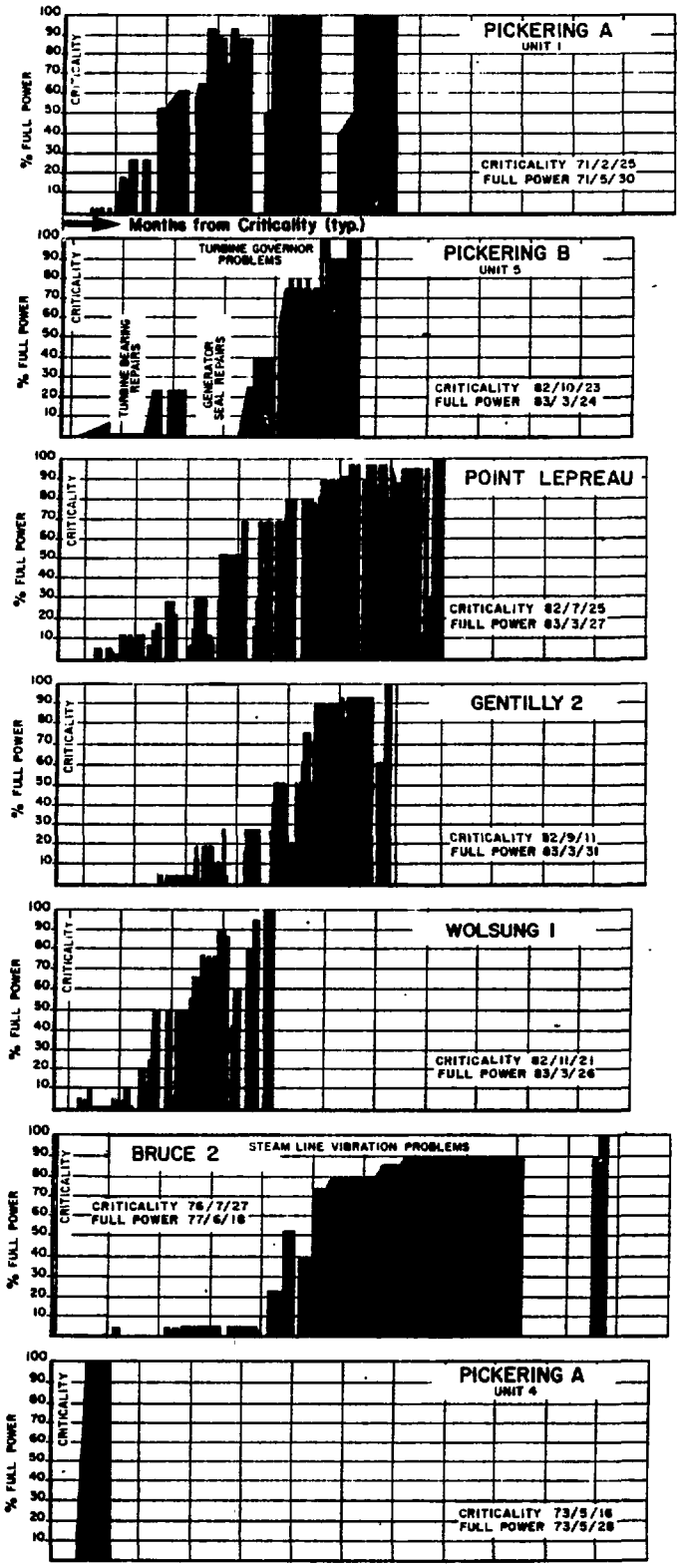


fig. 11

COMMISSIONING MANPOWER COMPARISON (FOUR UNIT PLANTS)

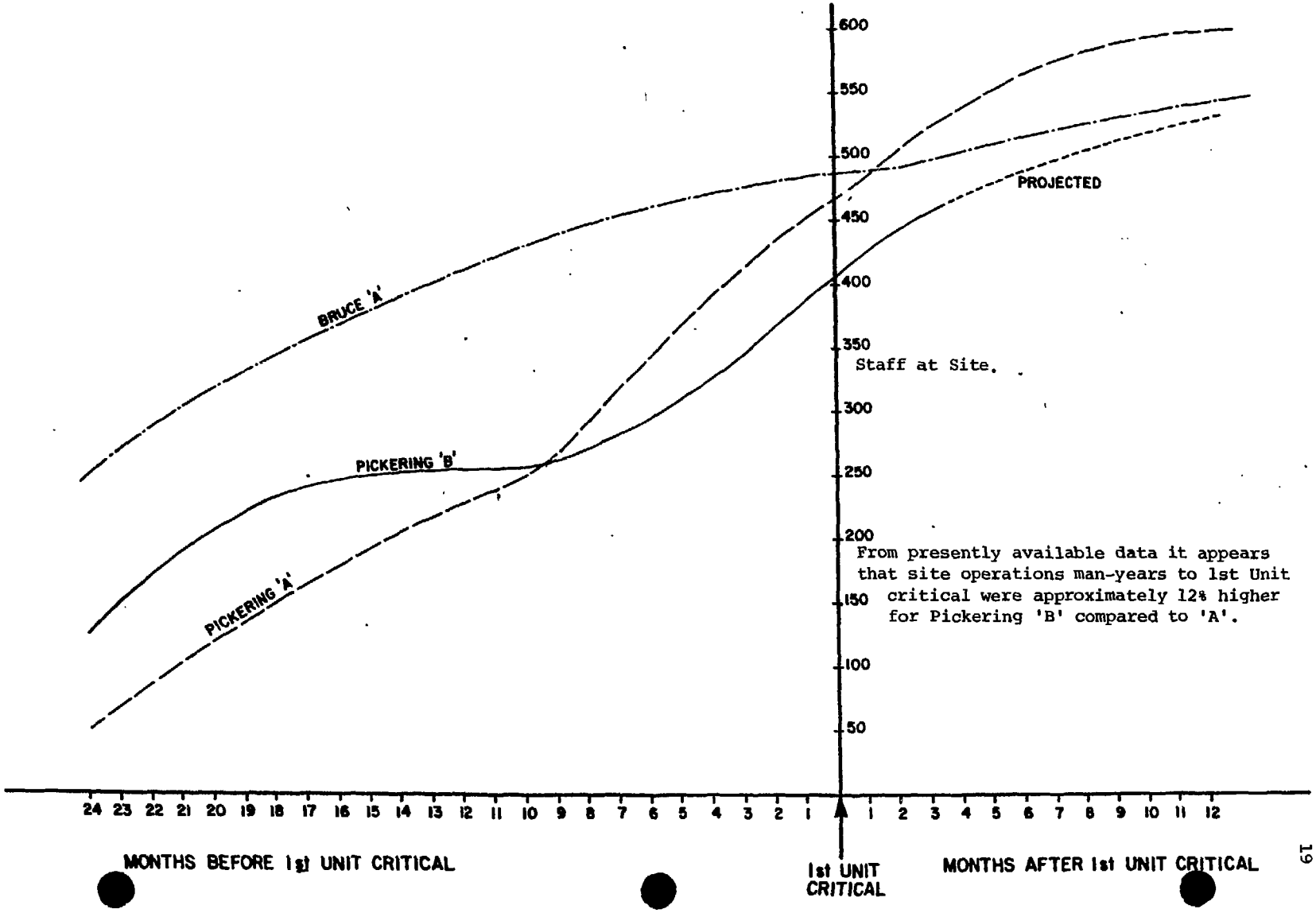


FIGURE #12

COMPARISON OF COMMISSIONING ACHIEVEMENTS AND SCHEDULES