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SUBJECT: LER 91-029-01:on 911031,discovered that incorrect Containment Atmospheric Control Recycle Flow Control controllers were installed for both divisions.Caused by less than adequate design.CAC was revised.W/920331 ltr.

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March 31, 1992
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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: NUCLEAR PLANT WNP-2, OPERATING LICENSE NPF-21
LICENSEE EVENT REPORT NO. 91-029-01

Transmitted herewith is Licensee Event Report No. 91-029-01. This report provides the results of the Supply System initiated Safety System Functional Inspection (SSFI) on the Containment Atmospheric Control (CAC) System. The original LER indicated a supplemental report was to be issued by March 1, 1992. However, the CAC review was not completed on that date as it became more involved than originally perceived. A preliminary review showed that outside expertise was required and this additional investigation has been underway. Based on a phone conversation between Mr. Mark Reis of the Supply System and Mr. Phil Johnson of your Region V office on February 27, 1992 the date for submittal of LER 91-029-01 was extended to March 31, 1992. This was to allow for completion of the CAC SSFI performed on the Hydrogen Recombiners. The SSFI and the associated consultants review has now been completed. This LER revision discusses reportable items that resulted from these efforts.

Sincerely,

J. W. Baker
WNP-2 Plant Manager (Mail Drop 927M)

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Washington Nuclear Plant - Unit 2	0 5 0 0 0 3 9 7	1 OF 10

TITLE (4)

Inadequate Primary Containment Hydrogen Recombiner Recycle Flow Control

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBERS(S)
1 0	3 1	9 1	9 1	-- 0 2 9	-- 0 1	0 3	3 1	9 2		0 5 0 0 0
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OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	[ ] 20.402(b)	[ ] 20.405(C)	[ ] 50.73(a)(2)(iv)	[ ] 77.71(b)
		[ ] 20.405(a)(1)(i)	[ ] 50.36(c)(1)	[X] 50.73(a)(2)(v)	[ ] 73.73(c)
		[ ] 20.405(a)(1)(ii)	[ ] 50.36(c)(2)	[X] 50.73(a)(2)(vii)	[ ] OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		[ ] 20.405(a)(1)(iii)	[X] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	
		[ ] 20.405(a)(1)(iv)	[ ] 50.73(a)(2)(ii)	[ ] 50.73(a)(2)(viii)(B)	
		[ ] 20.405(a)(1)(v)	[ ] 50.73(a)(2)(iii)	[ ] 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
C. L. Fies, Compliance Engineer	AREA CODE 5 0 9 3 7 7 - 4 1 4 7

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

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SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
[ ] YES (If yes, complete EXPECTED SUBMISSION DATE)	[X] NO				

ABSTRACT (16)

On October 31, 1991, a reportability evaluation was completed that concluded that a problem associated with flow control of the Primary Containment Hydrogen Recombiners was reportable. A contract engineer, performing a setpoint calculation review, had discovered that incorrect Containment Atmospheric Control (CAC) Recycle Flow Control controllers (CAC-FC-67 A/B) were installed for both divisions in the control room. The plant design and operating procedures required these instruments to be used in the automatic mode of operation to control recombiner recycle flow. If these incorrect controllers had been used in the automatic mode, they would not have controlled recycle flow which could have resulted in a reduced recombination rate or possible system shutdown due to excessive recombination.

Immediate corrective action was taken to change plant procedures requiring operation of these instruments in the manual mode. This allowed plant operators to control recycle flow from the control room by manually positioning the Recycle Flow Control Valve (CAC-FCV-6 A/B).

The root cause of this event was a less than adequate design and design change process during plant construction/startup. A second cause was less than adequate testing programs and procedures.

Further corrective action included a review of the design, testing, and operation of the CAC System by the Nuclear Safety Assurance Division. Nine man-months were spent by Supply System and Consultants on the review. Reportable concerns addressed by the SSFI included questions on control of the reaction and the operability of the catalyst. As a lesson learned from this experience, additional reviews will be performed on similar systems.

There was safety significance associated with events discussed in this LER revision since the operability of both divisions of one of the WNP-2 Engineered Safety Features was impacted. However, this safety significance is mitigated by the low probability of needing the CAC system with an inerted primary containment.

The event posed no threat to the health and safety of either the public or plant personnel.

Plant Conditions

Power Level - 100%
Plant Mode - 1

Event Description

At approximately 1200 hours on October 31, 1991, a reportability evaluation was completed that concluded a problem associated with the Containment Atmosphere Control (CAC) System was reportable. The problem with the flow instrumentation had been under review since it was discovered on August 7, 1991. A contract engineer identified the issue while evaluating the instrumentation associated with the CAC system as part of the Supply System's setpoint evaluation program. This event was reported under 50.72 at approximately 1500 hours on October 31, 1991.

At WNP-2 the CAC System includes redundant catalytic recombiners provided to combine the hydrogen and oxygen in the Primary Containment during degraded post-LOCA conditions. The recombiner subsystems (A and B) are located adjacent to the Primary Containment in the Reactor Building (Secondary Containment). Each redundant subsystem consists of a blower, wet scrubber, electric heater, catalyst vessel, after cooler, moisture seperator and associated instrumentation, valves and piping. A constant speed blower is used to draw the atmosphere from the Primary Containment, process it through the equipment and return it back to the Containment. The amount of recombination is controlled by the amount of recycle flow that is directed back through the unit. The amount of recycle flow is controlled by Recycle Flow Control Valve, CAC-FCV-6 A/B. As the amount of recycle flow is increased, the rate of recombination decreases. If CAC-FCV-6 A/B is fully closed, the system functions with single pass flow through the unit resulting in maximum recombination but risking subsystem shutdown due to high recombiner outlet temperature if the recombination rate becomes too high. Part of the instrumentation for the recombiner subsystem is associated with the control of recycle flow. CAC-FCV-6 A/B is controlled by a locally mounted Flow Indicating Controller, CAC-FIC-67 A/B, which receives a flow feedback signal from the Recycle Flow Transmitter CAC-FT-7 A/B. CAC-FIC-67 A/B, in turn, was designed to be controlled by remote Master Controller CAC-FC-67 A/B located in the control room.

The Remote Master Controller receives input on total flow from Flow Transmitter CAC-FT-6 A/B. CAC-FC-67 A/B should be, by design, ratio-type setpoint stations providing, in the AUTO mode, the setpoint signal to CAC-FIC-67 A/B. Plant Procedures PPM 2.3.3 A/B, Containment Atmospheric Control, Revision 0, would have been used for post-LOCA operation of the system. These procedures called for CAC-FC-67 A/B to be in automatic on system initiation.

The contract engineer discovered the fact that CAC-FC-67 A/B are proportional-integral controllers rather than ratio type controllers. These proportional-integral controllers receive total flow as a process feedback signal. Their output, however, only controls recycle flow. Hence, they are acting in an open control loop and their output will integrate either up or down until the recycle valves are full open or full closed. If the recycle valve went full open this would limit the containment gas flow through the scrubber and dilute the hydrogen concentration at the recombiner. The recombiner would continue to run under this condition but with reduced efficiency. If the recycle valve went closed, this could cause a high temperature rise across the recombiner, resulting in automatic system shutdown. The system would then have to be manually restarted.

Immediate Corrective Action

In August 1991, Plant System Operating Procedures, PPM 2.3.3 A/B, Containment Atmospheric Control, were revised to require operation of CAC with CAC-FC-67 A/B in the manual mode. The recycle flow (minimum recycle ratio) was to be set to the value given in the procedure. This ratio was provided as a function of containment pressure. The procedure called for the control room operator (Section 5.3, CAC Operation Following LOCA) to periodically monitor recombiner catalyst temperature and Drywell pressure to maintain minimum recycle ratio (maximum recombination) by adjusting CAC-FC-67 A/B (See discussion under paragraph A.8 below for more recent changes to the CAC Operating Procedures).

Further Evaluation and Corrective Action

A. Further Evaluation

1. This event is being reported per the requirements of 10CFR50.73 under three different paragraphs. First, it is reportable under 50.73(a)(2)(i)(B) as a "condition prohibited by the Plant's Tech Specs" since the system did not meet the OPERABLE definition contained therein. Second, 50.73(a)(2)(v) is also applicable as, "Any event or condition that alone could have prevented the fulfillment of the safety function..." in controlling the release of radioactive material and mitigating the consequences of an accident. Finally, 50.73(a)(2)(vii) is impacted since the event caused, "...two independent trains...to become inoperable...." in a single system designed to mitigate the consequences of an accident.

2. Past records indicate that this discrepancy has existed since initial Plant Startup. Startup Problem Report SPR I-1145, dated June 2, 1981, documents the discovery that the Bailey controllers supplied for initial installation were not correct. The Bailey devices installed in the Control Room were Model 701 003ADAE1 proportional-type controllers.

3. Further review showed that Design Change PED 218-I-3923 was issued on February 11, 1982 to respond to this problem. The design change specified a Bailey Model 715 030AAE1 ratio setpoint controller for CAC-FC-67 A/B. Further investigation revealed that this design change alone would not have been sufficient to correct the problem. The Recycle and Total Flow Transmitters (CAC-FT-7 A/B and CAC-FT-6 A/B) were calibrated to different ranges. Further, the feedback signal to the flow controller was a delta-P signal directly from the transmitter since square root converters had not been installed. Additional signal conditioning equipment would have been required to make the controllers (CAC-FC-67 A/B and CAC-FIC-67 A/B) function together correctly to control the Recycle Flow Control Valve CAC-FCV-6 A/B.

4. The correct Bailey ratio-type setpoint stations were never installed. The root cause investigation determined that a change in procurement responsibilities at the time the correct setpoint station was identified, led to the failure to procure and install the correct device. The Startup Problem Report was closed out based on the issuance of the corrected design and the recommended System Lineup Test.

5. A System Lineup Test was referenced on the Startup Problem report as being a required retest after replacement of the instrument. This test was performed in April 1983 but it was limited to a functional check of the incorrectly installed Model 701 003ADAE1 proportional-type controller.

6. The Preoperational Test on the system was performed in December 1983. The Test Procedure has a step which states, "Set FC-67 to recycle 55 percent of the gas leaving the phase separator." The procedure did not specifically require placing CAC-FC-67A/B in the auto position. The preoperational test did not discover the fact that the incorrect device was installed.

7. Various surveillance tests are performed on equipment associated with the CAC system. This includes an 18-month surveillance (4.6.6.1.b.1) which requires "Performing a CHANNEL CALIBRATION of all recombiner operating instrumentation and control circuits." Plant Procedure PPM 7.4.6.6.1.3 C/D, H2 Recombiner 1 A/B Flow Instrumentation Channel Calibration, performs this surveillance test. On November 21, 1991, during a further evaluation associated with this LER, it was discovered that this surveillance had not tested the operation of the Recycle Flow Control Valve, CAC-FCV-6 A/B, from the Remote Master Flow Controller, CAC-FC-67 A/B in the manual mode of operation. A trouble shooting plan was formulated and implemented that demonstrated movement of the CAC-FCV-6 A/B from the control room.

In early March 1992 additional testing was performed on the Hydrogen Recombiners to collect data on the performance of recycle flow control and to verify system operability. Plant Procedure PPM 8.3.248, CAC-HR-1A Recycle Flow Verification from Drywell, was performed on March 11, 1992. CAC-HR-1B Recycle Flow Verification from Drywell, was performed on March 12, 1992. These procedures established flow through the recombiner unit the way it would be configured during accident conditions; taking suction from the drywell and returning air to the wetwell. Recycle flow was controlled manually from the control room under a variety of flow conditions.

8. A review was performed of the 50.59 that implemented the change to PPM 2.3.3 A/B, System Operating Procedures for Containment Atmospheric Control (Division I/II). These procedures are referenced by the Emergency Operating Procedures and were changed previously (see Immediate Corrective Action above) to allow for manual operation of CAC-FC-67 A/B. The review found a Safety Evaluation was not performed on the change and one was completed on November 27, 1991. During the Safety Evaluation the discovery was made that operation of the system at 55 percent recycle flow could have resulted in automatic system shutdown due to high catalyst temperature caused by higher than expected flows through the system. This could occur since the flow measured by the preoperational test was higher than the flow assumed in the analysis. The analyzed flow was 65.7 scfm compared to the measured flow of 86 scfm at atmospheric pressure. Recombiner mass flow would be even higher at elevated containment pressures due to increased density. These high flows resulted in a recommendation for additional changes to PPM 2.3.3 A/B. A deviation to these procedures was approved on November 27, 1991, (Procedure Deviations 91-1126 and 91-1127) that required an additional operator to be stationed at the recombiner panel in the control room as soon as possible, but no later than six hours following a LOCA (the design analysis assumes the recombiners are started six hours post accident). This dedicated operator would provide added assurance that CAC recycle flow is monitored in a manner that would maximize the hydrogen and oxygen removal rate while preventing a high temperature shutdown. The plant operated with the procedures as described above until February 25, 1992.

The SSFI team questioned the manual method being used to control the CAC system. They believed that manual recycle control based on recombiner exit temperature was not acceptable. The instantaneous reaction rate associated with recombination could lead to high recombiner exit temperatures resulting in system shutdown at the trip setpoint of 1150°F. This concern was verified by the consultants (Bechtel and United Catalyst). Due to the transient nature of Post-LOCA operation oxygen or hydrogen fluctuations could come from a) localized pockets of unmixed gases, b) over compensating recycle flow control by the operator or c) increasing scrubber dehumidification capacity from resetting water flow. These fluctuations would be especially critical if the recombiners were operated near their upper temperature limits. As a result of this concern, Plant Procedures were changed to simplify operation of the CAC system. This change was performed with an appropriate 50.59 review and analysis. PPM 2.3.3 A/B, System

Operating Procedures for Containment Atmospheric Control (Division I/II) were changed to require the Plant Operators to place the CAC units on a constant 60 percent recycle flow under post-LOCA conditions. The EOPs provide for early startup of the CAC System at 0.5 percent hydrogen. This low hydrogen concentration combined with high recycle flow will provide a large margin between the operating point and the high temperature trip. At the same time, this will provide for an adequate hydrogen and oxygen recombination rate.

9. The review of the CAC system included a review of the results of the surveillance testing performed by Plant Procedures PPM 7.4.6.6.1.4/5, CAC-HR-1 A/B Functional Test and Visual Examination. These tests have been performed on each train of CAC seven times since plant startup. These tests are performed as required by Technical Specification 4.6.6.1.b.3 which states that at least once per 18 months a functional test will verify that "....upon introduction of one percent by volume hydrogen in a 140-180 scfm stream containing at least one percent by volume oxygen, that the catalyst bed temperature rises in excess of 120°F within 20 minutes." The review found that for the A train the 1990 test results gave a 114°F temperature rise which did not meet the temperature rise requirement of 120°F. The review of the B train surveillances found the flows in 1988 and 1989 were higher than allowed by the Technical Specifications with values of 217 and 188 scfm (indicated). The 1991 surveillances for both trains were checked and found to be satisfactory.

The SSFI review further questioned the operability of the catalyst. These questions involved potential halogen poisoning during postulated accident conditions and possible water damage due to wetting and flooding during past testing The consultant reviewed past data on halogen testing and the system design. Since the CAC system is designed with preheaters it operates with the feed temperature at 500°F. At this temperature halogen poisoning is not a concern since these gases are driven from the catalyst bed.

The consultant also re-reviewed past test data to determine the condition of the existing catalyst. Heat and mass balances were performed to estimate the amount of conversion in different sections of the catalyst bed for seven years of test data. This analysis showed that the bulk of the reaction was occurring in the top two sections of the catalyst bed as it should for a healthy configuration. The performance of the units was slightly different but within expected parameters. The analysis did show that the "A" bed performance was less efficient when compared to the "B". However, variation in the process variables and instrumentation inaccuracies on the two subsystem would also account for this difference.

On March 11 and March 12, 1992 the normal 18 month surveillance procedures for the catalyst, PPM 7.4.6.6.1.4/5, CAC-HR-1 A/B Functional Test and Visual Examination, were performed as part of the plant restart effort. During this test the "A" catalyst achieved a 102°F per percent hydrogen temperature rise. Thus, it did not meet the Technical Specification required 120°F per percent hydrogen.

The test results and associated analysis made it evident that the acceptance criterion of the Technical Specification was very dependent on the analytical methods of calculating the input parameters and measurement of performance indicators; hydrogen concentration, process flows and temperatures. Depending on the data, the temperature rise could vary significantly. The review had led to refinements in input parameter determination. As a result, during this review the temperature rise acceptance criterion required by the Technical Specifications was identified as suspect. In addition to the analytical methods used to determine the input parameters, other factors such as: heat removed by the gas flow; heat capacity of the catalyst bed and the vessel; losses through vessel insulation, supports, and piping; time lag and heat loss caused by temperature sensors and uncertainties in flow determination during testing, led to a conclusion that the present temperature rise acceptance criterion was not, by itself, an accurate reflection of catalyst operability. Test results showed variations primarily are a result of the ability to set initial conditions, input parameters, and instrument uncertainty.

The SSFI concluded that sampling of the influent and effluent gases would be a more direct indication of catalyst efficiency. This was confirmed with the assistance of industry experts in catalyst bed design and operation. An appropriate acceptance criterion would be the sampling of the effluent gas stream for hydrogen concentration for a defined input volume percent of hydrogen. A sample retaining less than 25 parts per million by volume (ppmV) hydrogen after passing through the catalyst bed would indicate acceptable recombiner operation for a feed of at least one percent hydrogen by volume. In response to this recommendation the normal 18 month surveillance procedures for the catalyst, PPM 7.4.6.6.1.4/5, CAC-HR-1 A/B Functional Test and Visual Examination were modified to require sampling of hydrogen at both the inlet and outlet of the recombiner. The sampling performed on March 11 and 12 showed 6 ppmV hydrogen concentration in the effluent stream of both recombiner trains with the "A" train showing slightly better performance. It was these test results that led the Supply System to conclude that the catalyst efficiency was acceptable and capable of performing in support of plant operation.

B. Root Cause

The root cause of these events was a less than adequate design and design change implementation. Design Change PED 218-I-3923 was not driven to completion by the change process during construction and plant startup testing. The second root cause was less than adequate testing that should have identified the catalyst control problems discussed above at an earlier date.

C. Further Corrective Action

1. The design change process in place during construction depended on contractors to implement changes that were issued by the Architect-Engineer. It is concluded, based on the turnover process put in place at the end of construction, that the failure to implement Design Change

PED 218-I-3923 is an isolated occurrence. The construction design change process in place when this event began was completely changed when the plant went into operation. Therefore, no further corrective action is warranted.

2. A Safety System Functional Inspection (SSFI) was performed on the CAC System by the Nuclear Safety Assurance Division. Standard methodology was used which included the establishment of a design basis, and review of system parameters against the design.

3. A more general action being taken in response to the problems associated with the CAC System involves the identification of other systems that may have characteristics similar to those which are believed to have contributed to the CAC situation. This evaluation considered seven criteria: 1) Late additions to plant design, 2) Not fully testable, 3) Not fully designed by Burns and Roe 4) Not fully designed by General Electric 5) Low work control priority, 6) Importance of the system to Plant Organizations and 7) Current status of system deficiencies. The results of this evaluation recommended four systems for consideration of additional reviews: Control Room Chillers, Post Accident Sampling, Main Steam Leakage Control and Process Radiation Monitors. An engineering evaluation will be performed for each system. This will be followed by a limited team inspection. It is our goal to have all evaluations and inspections completed by December 31, 1992.

4. Plant Procedure PPM 7.4.6.6.1.3.C/D will be revised to incorporate a test of the CAC-FC-67 A/B to CAC-FCV-6 A/B instrument control loop.

5. CAC surveillance procedures will be validated and verified to assure all Technical Specification functions are being performed.

6. CAC operating procedures were validated and verified.

7. A Technical Specification amendment has been requested to surveillance requirement 4.6.6.1.b.3. The requirement will read: "Verifying during a recombiner system functional test that, upon introduction of at least one percent by volume hydrogen into the catalyst bed preheated to a temperature not to exceed 300°F, the effluent stream has a hydrogen concentration of less than 25 ppm by volume."

Safety Significance

We believe this event has safety significance since the operability of both divisions of one of the WNP-2 Engineered Safety Features was impacted. However, the actual safety significance is mitigated by the very low probability of the need for the system given the inerted primary containment.

In the design basis analysis, the probability of hydrogen production following a large LOCA event has been assessed by the Supply System PRA effort. A large LOCA can be due to pipe break or due to failure of sufficient SRV's to open when needed. On the basis of generic failure rate for pipes and plant-specific failure rate for SRV's, the probability of a large LOCA has been determined. A large LOCA event can be mitigated as long as any one of the ECCS systems operate. Plant-specific system unavailabilities have also been determined. The hydrogen production (or a LOCA without coolant injection) probability can be assessed by multiplying the LOCA probability by the product of the ECCS System unavailabilities. This number is approximately 1E-7/year. NRC's safety goal is 1E-4/year for core damage and 1E-6/year for containment failure. Although hydrogen production does not mean there is a subsequent burn or containment failure, hydrogen production probability already meets the safety goal for containment failure.

Severe accident studies done in support of Individual Plant Evaluation (IPE) work has shown that the amount of oxygen generated and surviving as a gas in a degraded core scenario is very small. With an inerted containment the oxygen concentration is not likely to exceed acceptable limits precluding the need for the hydrogen recombiners. In addition, the initial work being done on the WNP-2 IPE concludes that CAC is a negligible contributor toward accident mitigation. For core melt accidents, the exothermic metal water reaction, once started, generates large quantities of hydrogen. Since there is a limited amount of oxygen that can be reacted it is of marginal value. Hydrogen combustion is not a possible containment failure mechanism for an inerted containment (Reference: FAI/91-110, Deflagration and Detonation of Hydrogen, July 1991).

Similar Events

The events related to CAC as discussed in this LER and recent related LERs on CAC are unique. The condition of the system and the number of problems found are not comparable to any other events reported at WNP-2.

LER 92-003 reported the event where incorrect drawing information regarding overloads led to both divisions of CAC being inoperable during power operation. Corrective action is underway for this event.

LER 92-007 reported the problems associated with the CAC drain line that resulted in a plant shutdown in late February 1992. These problems have been corrected by piping modifications and verified by system testing.

EIIS Information

Text Reference	EIIS Reference System	EIIS Reference Component
Primary Containment Hydrogen Recombiner	BB	RCB
Containment Atmosphere Control (CAC) System	BB	--
CAC Recycle Flow Controller (CAC-FC-67 A/B)	BB	FC
CAC Recycle Flow Control Valve (CAC-FCV-6 A/B)	BB	FCV
CAC Recycle Flow Transmitter (CAC-FT-7 A/B)	BB	FT
CAC Local Recycle Flow Indicating Controller (CAC-FIC-67 A/B)	BB	FIC
CAC Total Flow Transmitter (CAC-FT-6 A/B)	BB	FT
Containment Monitoring Control Panels (CMS-CP-1301/1401)	IK	PNL
Containment Monitoring System Hydrogen Recorders (CMS-H2R-1/2)	IK	R
CAC Recombiner Fan (CAC-FN-1 A/B)	BB	FN