ATTACHMENT 1

Letter from C. R. Steinhardt (WPSC)

to

Document Control Desk (NRC)

dated

July 9, 1997

Re: Response to Apparent Violation in Inspection Report No. 50-305/97006

NRC Notice of Apparent Violation 97-006-03 (305/97006-03)

During a routine inspection period, the NRC identified an apparent violation of the requirements of 10 CFR Part 50, Appendix B, Criterion III, "Design Control". The violation is being considered due to Kewaunee plant staff identifying that the Reactor Vessel Level Indication System (RVLIS) had a design error since the system was installed in 1986. The design error precluded compliance with Technical Specification 3.5.e during times the plant was operated. The cause of the condition was determined to be an improperly implemented software modification. Further considerations are being given to a violation due to Kewaunee staff also identifying that the error was not identified during pre-operational testing.

WPSC Response

Wisconsin Public Service Corporation agrees that a violation occurred. RVLIS is one of the accident monitoring instruments required by the Kewaunee Technical Specifications. The design error resulted in a degraded condition that rendered the system unable to accurately measure vessel level over the required span.

The degraded condition was discovered when plant personnel analyzed historical data from the plant process computer and questioned apparent discrepancies between the vessel level displayed by RVLIS, one of the subsystems of the Inadequate Core Cooling Monitoring System (ICCMS)[IG], and those displayed by the Refueling Water Level Indicator during reduced inventory conditions of prior outages.

The analysis of this data was part of an evaluation to determine the effect of a collection of nitrogen gas in the reactor vessel head on refueling level indication during draining to a reduced inventory condition. The objective of analyzing RVLIS and Refueling Water Level data from prior outages was to gain an understanding of the baseline values generated by these instruments during normal drain and fill operations. This analysis was performed in advance of entering reduced inventory conditions at the conclusion of the outage. In the past, RVLIS has not been

monitored during draining operations. Operations procedures direct the operators to monitor refueling level indications and volumes drained to monitor the progress of draining. The historical data was examined to see if RVLIS could be used to indicate the presence of a bubble in the vessel head during draining.

Reason For Violation

The cause of this event is discussed in detail in Licensee Event Report 97-003 (included as attachment 2). In summary, this event was caused by a failure of WPSC and the vendor, Combustion Engineering (CE), to properly implement a change in the RVLIS range of indication. This change was made in July, 1985, seven months prior to installation. The original range of indication was from the elevation of the RVLIS pressure transmitters, several feet below the top of the reactor core, to the top of the reactor vessel head. The new range was from the bottom of the rcactor vessel hot leg penetrations to the top of the reactor vessel head. This change impacted two arcas of the system. First, the reactor vessel mimic located on the control room panel needed to be changed. Second, the RVLIS equations that calculate vessel level in the ICCMS software also needed to be changed. Inadequate communication between WPSC and CE resulted in a partial implementation of the new range. The control room mimic was modified to reflect the new range. The ICCMS software was not modified.

In addition, pre-operational testing of the system failed to identify the error. Pre-operational testing did not include a comparison of values obtained by RVLIS with actual water level in the vessel during reduced inventory conditions. Such a test would have revealed the error. This test was not performed due to the timing of ICCMS installation relative to reactor refueling activities. During the 1986 refueling outage, installation of the ICCMS processor and its associated instruments and cabling occurred concurrent with reactor refueling activities. Once ICCMS installation was completed, near the end of the outage, refilling of the reactor vessel had already been completed. Therefore, the opportunity to observe actual process data from the ICCMS during reduced inventory conditions did not exist.

The testing that was conducted consisted of two parts. First, simulated process signals were applied to the ICCMS processor and the calculated results were confirmed. The system passed this test since the test procedure also reflected the design error. Second, actual process readings were taken from the differential pressure transmitters and compared to predicted values. This test also passed since the design error had no impact on the differential pressure read by the transmitters.

Corrective Actions

To correct the degraded condition, a software change was implemented under WPSC's Physical Change process. Re-test of the system following this change correlated values obtained from the RVLIS system to actual water level in the reactor vessel during reduced inventory conditions. Actual water level was determined by obtaining values from the Refueling Water Level instruments, sight glass observation, and visual observation of water level in the hot leg during nozzle dam removal. This retest confirmed the revised RVLIS software is accurately calculating vessel level.

To assess the need for additional corrective action to prevent future occurrence, the processes that control software development and modification were reviewed. The error that occurred in 1985 was caused by a breakdown in communication within the ICCMS project team. The processes currently in place for plant design changes and software development and control decrease the likelihood that a personnel error such as inadequate communication would not be detected.

In the current processes, a formal software development methodology exists. Specifically Nuclear Administrative Directive (NAD) 5.23, "Software Development and Control", defines seven phases in the software development life cycle. They are: requirements, design, implementation, test, installation and checkout, operation and maintenance, and retirement. NAD 5.23 was initially issued on October 27, 1992. A software modification implemented today would be subjected to a more formal requirements and design phase prior to

implementation. These preliminary steps ensure that the impact on the system is fully understood and accounted for prior to implementation of the modification.

NAD 5.23 also requires that all software changes to plant process monitoring and control software are subjected to the additional requirements of NAD 4.3, "Plant Physical Change". This ensures software changes are subjected to the same requirements as any other change to a plant system.

The strengthening of the software development process since 1985 provides reasonable assurance that future modifications will accurately identify all areas impacted by a design change.

During the retest of this software change, an additional deficiency was identified in the RVLIS system. This deficiency results in the potential for a non-conservative indicated level [LI] error of as much as ten percent. The maximum level error occurs when the reference chamber at the top of the RVLIS differential pressure transmitter reference leg fills with water and fails to drain as the reactor vessel [RPV] level falls below the reactor vessel head connection. This deficiency is discussed in detail in Licensee Event Report 97-007 (reference 2).

Compliance Schedule

Corrective actions were completed under Kewaunee Assessment Process (KAP) 680 and Design Change (DC) 2904 on June 9, 1997

ATTACHMENT 2

Letter from C. R. Steinhardt (WPSC)

to

Document Control Desk (NRC)

dated

July 9, 1997

Re: Reportable Occurrence 97-003-00

NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Kewuanee Nuclear Power Plant	05000305	1 OF 8

TITLE (4)

Plant Operation Outside of Tech Specs with Reactor Vessel Level Indication Out of Service

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 NAME	DOCKET NUMBER
03	10	97	97	-- 003	-- 00	04	09	97	N/A	05000
									FACILITY NAME	DOCKET NUMBER
										05000

OPERATING MODE (9)	N
POWER LEVEL (10)	000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)	X	50.73(a)(2)(i)
	20.2203(a)(1)		20.2203(a)(3)(i)	X	50.73(a)(2)(ii)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)

	50.73(a)(2)(viii)
	50.73(a)(2)(x)
	73.71
	OTHER Specify in Abstract below or in NRC Form 366A

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Gerald R. Tyrrell	(414)388-2560, Ext. 2629

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

	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPROS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

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

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On March 10, 1997, with the plant in refueling shutdown, a design error was identified in one of the subsystems of the Inadequate Core Cooling Monitoring System (ICCMS), the Reactor Vessel Level Indicating System (RVLIS). As a result the RVLIS is incapable of performing its intended function over its required span. The cause of this event is failure to properly implement changes to the design as refinements were made in the early phases of the project prior to installation.

This condition has existed since the system was installed in 1986. Kewaunee Technical Specifications (TS) require the RVLIS to be operable when above the hot shutdown operating mode. Therefore, the plant was operated in violation of the TS since the system was installed.

Currently, Kewaunee is in an extended outage completing steam generator repairs. The RVLIS system is not required during this plant mode. Prior to the reactor being made critical following the current outage, a software change will be implemented to correct the system.

The ICCMS was designed by Wisconsin Public Service and built by Combustion Engineering (CE). The Kewaunee system does not use the standard CE ICCMS software used at other nuclear power plants.

DESCRIPTION OF EVENT

On March 10, 1997, with the plant in refueling shutdown, a design error was identified in one of the subsystems of the Inadequate Core Cooling Monitoring System (ICCMS)[IG]. The error was identified in the calculation of reactor [RCT] vessel [VSL] level when both reactor coolant pumps [P] are off. The error results in an offset in the displayed vessel level by as much as 35% of measured span in the non-conservative direction. The degraded condition was identified when plant personnel questioned apparent discrepancies between the vessel level displayed by ICCMS and those displayed by the Refueling Water Level Indicator during reduced inventory conditions.

ICCMS consists of four subsystems: the Core Exit Thermocouple Monitor, the Subcooled Margin Monitor, the Reactor Coolant System (RCS)[AB] Void Fraction Indicator (used when one or both reactor coolant pumps are running), and the Reactor Vessel Level Indicating System (RVLIS). The error is contained in the RVLIS module. RVLIS is designed to provide a direct indication in the control room of the water level in the reactor vessel when both reactor coolant pumps are off. It is based on measurement of differential pressure. It contains a top fluid connection on the reactor vessel head and a bottom fluid connection to a coupling in an in-core detector thimble guide tube. The design of the RVLIS is to provide post-accident reactor vessel level indication to enable determination of the magnitude of any void formation.

The ICCMS uses a microprocessor to process the outputs of the RVLIS differential pressure transmitters [PDT] and provide display of vessel level in the control room. To compensate for changes in fluid density, the ICCMS uses data from resistance temperature detectors (RTDs) mounted on vertical sections of the sensing line tubing, core exit thermocouples, RCS cold leg RTDs, pressurizer [PZR] pressure transmitters, and RCS pressure transmitters. The system was installed during the Spring, 1986 refueling outage.

Investigation of the discrepancy between the two level indicators [LI] revealed an error in the equations used by the ICCMS to calculate vessel level when both reactor coolant pumps are off.

The preliminary RVLIS design called for the calibrated span to be defined as one hundred percent level equal to the top of the reactor vessel, and zero percent level equal to the elevation of the RVLIS differential pressure transmitters, several feet below the top of the reactor core. A internal RVLIS design review meeting was held by Wisconsin Public Service (WPS) on July 17, 1985. During that meeting, a concern was raised regarding the ability of the system to provide an accurate indication of vessel level once level dropped below the top of the reactor core. This concern was based on the instruments used to compensate for density changes in the reactor coolant.

[redacted]o determine the density of liquid in the reactor vessel, RVLIS uses values obtained from the core exit thermocouples. When vessel level drops below these instruments, located at the top of the reactor core, the system is no longer able to accurately determine the density of the remaining liquid in the vessel.

To address this concern, the calibrated span of the system was changed at the July, 1985 meeting. One hundred percent continued to be defined as the top of the reactor vessel. Zero percent level was redefined as the bottom of the vessel hot leg penetration. However, this change was only partially implemented. The reactor vessel mimic located next to the RVLIS meters on the control room panel was changed. One of the software constants used in the equations to calculate vessel level was not changed. This left the system in a condition where vessel level was calculated and displayed based on the original calibrated span, but the vessel mimic used by the operators to correlate the readings to the vessel showed the new span.

The offset caused by the error increases as vessel level drops. When the rcactor vessel is full, the offset [redacted]uced is zero. With level at the reactor head flange, the offset is approximately 15%. With level at the bottom of the reactor vessel hot leg penetrations, the offset is approximately 35%.

This error only impacts the RVLIS portion of the ICCMS. The Core Exit Thermocouple Monitor, Subcooled Margin Monitor, and RCS Void Fraction Indicator are unaffected and able to function as an aid to the operator post-accident.

The ICCMS was designed by WPS and built by Combustion Engineering (CE). The Kewaunee system does not use the standard CE ICCMS software used at other nuclear power plants. The change in design made in July 1985 applied only to the Kewaunee system. CE has been informed of the error in the Kewaunee system.

CAUSE OF THE EVENT

The cause of this event is failure of WPS and the vendor, CE, to properly implement changes to the design as refinements were made in the early phases of the project. The change in calibrated span was made seven months prior to shipment of the system to the site. However, the change was only partially implemented in the system as delivered. The necessary change was made to the control room panel mimic, but the corresponding changes to one of the constants used in the RVLIS equations in the ICCMS processor were not made. In addition, changes to system documentation and test procedures were not made.

WPS had opportunities to detect the error prior to placing the system in service. The final system design specification, containing the erroneous equations, was transmitted to WPS by the vendor subsequent to the design change, but before the system was placed in service. In addition, pre-operational testing failed to discover the error. A test which correlated actual RVLIS data to the refueling water level system would have revealed the error. Such a test was not performed. The testing that was performed measured the actual, uncompensated differential pressure for zero, one, and two pump operation at various RCS temperatures and compared that actual data with expected values. The change in span had no impact on the

uncompensated differential pressure from the transmitters and therefore, the test did not detect the error. Additional testing was performed on the ICCMS microprocessor. These tests involved applying test signals to the various ICCMS inputs and observing the outputs, including vessel level. However, those test procedures were based on the original span of measurement for RVLIS. Accordingly, the system met acceptance criteria for the test procedure as written.

Opportunity to detect the error during any of the previous outages since installation was limited. During a normal outage, disassembly of the core exit thermocouples cables and the pressure sensing line from the reactor head to the RVLIS transmitter reference chamber are among the first activities of the outage. Reassembly is typically one of the final activities near the end of the outage. When this equipment is disassembled, RVLIS does not have the data necessary to determine level. LEDs (light-emitting diodes) on the RVLIS meters in the control room flash to indicate to the operator that the system is out of service. In addition, even when this equipment is in place, other outage activities such as calibration of instruments used by RVLIS render the system out of service. As a result, the operators have not relied on RVLIS as a reliable indication of vessel level during the time the RCS was in a reduced inventory condition.

During the current extended outage, RVLIS was fully assembled and operational during periods where vessel level was less than 100%. It was during this time that the error was observed.

Periodic surveillance testing conducted since system installation also did not reveal the error. This testing consists of providing signals of a known value as inputs to the instruments, observing the output, and making any necessary adjustments. Surveillance testing that observes actual process measurements and then correlates those values to the actual condition of the reactor coolant system would have been required to detect this error. Such a test was not part of the normal surveillance of the ICCMS.

ANALYSIS OF THE EVENT

This event is being reported in accordance with the requirements of 10CFR50.73(a)(2)(I)(B), "a condition prohibited by the plant's Technical Specifications," and 10CFR50.73(a)(2)(ii)(B), "a condition that resulted in the plant being in a condition that was outside the design basis."

Kewaunee Technical Specifications (TS) require that the Reactor Vessel Level Indication instrumentation be operable, whenever the plant is above hot shutdown. Kewaunee's RVLIS provides two channels of level indication. With the error found, both channels are inaccurate below 100% reactor vessel level. Under this condition, the instruments do not provide accurate indication of vessel level over the required span and are therefore inoperable. Therefore, the plant had operated outside of the TS requirements, since RVLIS was installed in 1986.

The RVLIS is part of the plant's required accident monitoring instrumentation. The RVLIS supplements other available information to aid the operator in assessment of plant conditions during and following an accident. The development of generic emergency operating procedures acknowledges the supplemental nature of the RVLIS indication by providing guidelines with or without RVLIS.

The impact of the level instruments' indication error is that under specific accident conditions an inaccurate indication of reactor vessel level would have occurred. This could have in turn resulted in a non-conservative estimation of vessel void formation.

Specifically, Kewaunee's Integrated Plant Emergency Operating Procedures (IPEOPs) reference three different action levels associated with RVLIS. They are: (1) "GREATER THAN 100%," (2) "GREATER THAN 30%," and (3) "GREATER THAN 0%." For those instances where operator decisions are based on the 100% level, the degraded condition of RVLIS has no impact. No error is introduced at 100% or more.

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL	REVISION	
Kewaunee Nuclear Power Plant	05000305	97	-- 003	-- 00	7 OF 8

TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

Operator action based on 30% RVLIS appears in IPEOP ES-0.3, "Natural Circulation Cooldown With Steam Void In Vessel." This procedure provides actions to cool down and depressurize the plant to cold shutdown conditions when no accident is in progress. Entry into this procedure is from ES-0.2, "Natural Circulation Cooldown" and only when the RCS must be depressurized. The intent of monitoring RVLIS in this procedure is to confirm vessel inventory above the top of the hot leg to ensure voids do not migrate to the top of the steam generator U tubes. While any void formed is expected to collapse within the hot leg fluid, void migration could occur with the disruption of natural circulation. With RVLIS error, a displayed reading of 30% is below the top of the hot leg. Consequently, in this condition voids could have migrated beyond the reactor vessel.

[redacted]rator action based on 30% vessel level also appears in IPEOP ECA-3.2 "Steam Generator Tube Rupture With Loss Of Reactor Coolant - Saturated Recovery Desired." This procedure directs the operator actions for the beyond design basis event of a steam generator tube rupture with a loss of reactor coolant. In this procedure, the RVLIS indication is one of two parameters used to reinitiate safety injection flow in order to maintain a covered reactor core. With RVLIS error, 30% displayed level is still above the top of the core (approximately the bottom of the hot leg). Core exit thermocouples indication serves as the alternate parameter to monitor core coverage and would also ensure re-initiation of safety injection if required.

Operator action based on the 0% value is contained in IPEOP ECA-3.3 "Steam Generator Tube Rupture Without Pressurizer Pressure Control." This procedure directs operator actions for the beyond design basis event of a steam generator tube rupture with loss of normal and auxiliary pressurizer sprays and power operated relief valves. In this procedure, a RVLIS reading of greater then 0% is used to confirm that the [redacted]or core is covered prior to terminating safety injection flow. This is one of four conditions that need to [redacted] met to terminate safety injection. Core exit thermocouples are also required to demonstrate RCS

FACILITY NAME (1)	DOCKET	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL	REVISION	
Kewaunee Nuclear Power Plant	05000305	97	-- 003	-- 00	8 OF 8

TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

subcooling is present. With inventory level below the top of the core, a subcooled indication from core exit thermocouples would not exist. Therefore, safety injection being terminated with reactor vessel inventory below the top of the core is not considered credible.

Currently, Kewaunee is in an extended outage completing steam generator repairs. The RVLIS system is not required during this plant mode. During reduced inventory conditions associated with outage activities, the refueling water level indicator, not RVLIS, is relied upon for level indication.

CORRECTIVE ACTIONS

Prior to the reactor being made critical following the current outage:

1) A software change will be implemented to correct the RVLIS equations. The calibrated span will be 100%, top of reactor vessel and 0%, bottom of the hot leg.

2) A retest will be conducted to confirm the implemented change.

ADDITIONAL INFORMATION

None.

SIMILAR EVENTS

None.