STATE OF VERMONT
DEPARTMENT OF PUBLIC SERVICE
120 STATE STREET
MONTPELIER, VT 05620-2601
TEL.: (802) 828-2811
FAX: (802) 828-2342
TTY/TDD (VT): 1-800-734-8390

VERMONT STATE NUCLEAR ADVISORY PANEL

July 17, 1995

Mr. David Chawaga, State Programs
U.S. Nuclear Regulatory Commission -- Region I
475 Allendale Road
King of Prussia, PA 19406

Dear Mr. Chawaga:

In this letter, we request information regarding inspections performed on various core components which are susceptible to age cracking. We also ask your comment on the avisability and need for mid-cycle inspections of the Vermont Yankee Core Shroud.

For our Vermont State Nuclear Advisory Panel meeting of May 23, 1995, we received the attached letters from Michael J. Daley and the Citizen Awareness Network on the subject of the adequacy of reactor internals components. The letters identify core components which are susceptible to age cracking, and continue to request a mid-cycle inspection of these components and an NRC public meeting.

In order to assist us with our considerations, we request the following:

1. The regulatory requirement for inspections for the core components identified as age cracking susceptible in either NUREG/CR-5754 or the list of Oyster Creek items provided by NIRS.

2. The safety implications for cracking in the core components identified as age cracking susceptible in either NUREG/CR-5754 or the list of Oyster Creek items provided by NIRS.

3. A comment on whether more accurate inspection methods are available than those which Vermont Yankee uses for these inspections, and the advisability of using more accurate techniques.

4. A comment of the advisability and need for a mid-cycle inspection of the Vermont Yankee core shroud.

We would appreciate any other information you could provide to assist our consideration of this issue. We plan to take up this issue in a Panel meeting this Fall and hope that NRC will be able send a representative to participate.

Sincerely,

William K. Sherman
For the Panel

Michael J. Daley
RFD#3, Box 627
Putney, Vermont 05346
(802) 387-2601

MAY 23 2 13 PM '95

May 19, 1995

Dear Members of VSNAP:

I regret that I cannot be present at your meeting on May 23. I will be close by, however, educating the public about the safe, clean alternatives to Vermont Yankee at the 7th Annual Tour De Sol solar and electric car race. Perhaps you can stop by the Brattleboro High School after your meeting. Governor Dean will be on hand to drive Vermont's entry across the finish line.

I am writing to share my concern that Vermont Yankee officials (with NRC's blessing) have prematurely screwed the cap back on their reactor.

Some members may recall meeting, in Spring 1992, with nuclear safety expert Robert Pollard of the Union of Concerned Scientists. At that meeting, he told the Panel that degradation of safety components due to aging is one of most significant safety issues confronting the nuclear industry. I believe the Panel has come to share an interest in this subject.

In recent conversations with NECNP Trustee Diana Sidebotham, Mr. Pollard indicated that core shroud cracking is the tip of the iceberg where age-related degradation is concerned. The stainless steel alloy used in the shroud is particularly susceptible to intergranular stress corrosion cracking (ISCC). (Note: VY had to replace the entire main coolant loop piping in the mid-1980s due to ISCC.)

This same alloy is used in numerous other reactor internals, many with safety related functions. A report prepared by the Nuclear Information and Referral Service (NIRS, a Washington, DC based industry watchdog) identified over 25 areas of concern at the Oyster Creek reactor (also a BWR and this report is enclosed for your information). To the best of my understanding, upon identifying the core shroud cracks using an advanced ultrasound technique, Vermont Yankee did not expand the inspection to include other susceptible components. (These will not necessarily be the same as those at Oyster Creek. Vermont Yankee should supply panel--and the public--with an inventory of all components containing alloys similar to the core shroud.)

Vermont Yankee's failure to extend their inspection is particularly disturbing given the historic inability of previous (now outmoded) inspection methods to identify cracking. For example, before applying advanced technology to the inspection of steam generator tubes, the Maine Yankee plant had identified about 500 flawed tubes out of 17,000 total. Advanced inspection methods have today identified flaws in more than half of the tubes -- over 8,000. In the

words of NECNP President and Maine resident, Jim Perkins, "the old method missed virtually all of the problem".

The situation is similar at Vermont Yankee. During the Fall 1998 outage, Vermont Yankee made a visual inspection of the shroud with a 1 millimeter resolution video camera. This method revealed no cracking. When ultra sound techniques were applied in this outage, cracks were "discovered", one penetrating half way through the shroud.

This raises some troubling issues:

Were there no cracks in 1998? If so, these current ones must have appeared in just one operating cycle. When in the cycle did they develop?

Or were the cracks present, but missed? If so, how can any assurance be given that safety related components using similar alloys are crack free?

Further, without accurate records of when cracks first appeared (and their actual growth rates over time), how can Vermont Yankee determine a reference point to use in calculating growth rates?

I hope some answers will emerge from your meeting with Vermont Yankee officials.

I am indebted to the Citizen Awareness Network (CAN) for bringing much of this information to my attention. They have been in constant communication with the NRC since the cracks were discovered. The accompanying letter from CAN President Debby Katz more fully outlines their concerns, which we share.

The New England Coalition and Citizen Awareness Network intend to ask the NRC to require a mid-cycle inspection of the core shroud and related safety components. This would be followed by an NRC public hearing to explain the results to the public before the plant restarted.

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Complex uncertainties are involved when materials are subjected to the harsh nuclear environment that make predication difficult. In such situations, the Yankee Rowe and Maine Yankee experiences have clearly demonstrated that public health and safety is best assured by stopping to take a look at real cracks rather than relying on computer modeling.

After your consideration of this issue, I hope you will join us in calling for a mid-cycle inspection and hearing.

I look forward to the results of your deliberations.

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Michael J. Daley

CITIZEN AWARENESS NETWORK Box 83 Shelburne Falls, MA 01370 May 23 2 13 PM '95

Telephone 413-625-8401
Fax 413-339-5781

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Dear Members of Vermont State Nuclear Advisory Panel

Citizens Awareness Network is here to express our concern about the Shroud Inspection and Flaw Evaluation of the Vermont Yankee Nuclear Power Station. During the recent refueling outage. Vermont Yankee identified cracking in the circumferential welds in the core shroud. There was intergraunular stress corrosion cracking(ISCC) in all welds except for H7. The cracking in Weld # H5 was over 1" in depth. The shroud is 2" thick and fourteen feet high. This cracking information was ascertained through ultrasonic testing. The VY shroud was fabricated using high carbon Inconnel 304 stainless steel , and has been found at other reactors to be susceptible to ISCC. This cracking is of concern to citizens living in proximity to the reactor because other safety related components are fabricated from this material.

In "Boiling Water Reactor Internals Aging Degradation Study", NUREG/CR-5754, issued in September 1993, major aging mechanisms where identified that are limiting the functional life expectancy of safety-related components in BWRs. The report documents the potential effects of aging on 25 BWR internal components. Components fabricated from cast austenitic stainless steel (Type 304 widely used in the industry and at Vermont Yankee) are embrittling by prolonged exposure to high temperature, corrosive water chemistry, neutron bombardment, and fatigue resulting in stress corrosion cracking. Neither the industry nor the NRC are able to fully understand the growth rate mechanism of cracks and the subsequent rate of deterioration of the systems.

Notwithstanding this, the NRC has granted the licensee permission to operate until the next refueling which is scheduled for September, 1996, 18 months from now. The reactor was able to demonstrate that there is sufficient structural liganents to justify one additional cycle of operation. At that time the reactor will be required to reinspect and/or repair the shroud. The corrosive cracking of the core shroud is in fact a bell weather for the potential embrittlement and subsequent failure of these other components. Many of these components are safety related.

These components include:

- **Core Spray Sparger**, which injects cooling water into the core in the event of a loss of coolant accident to prevent the fuel cladding from melting. Cracks in the CSS can "potentially alter the flow of coolant to the core and might lead to the generation of loose parts in the reactor pressure vessel".(NRC)

- **Core Spray Annulus Piping**, safety related, this is a component of the Core Spray System which supplies cooling water to reactor fuel assemblies during a loss of Coolant Accident.

- **Feedwater Sparger**, safety-related, provides subcooling, homogenous and uniform temperature mixing to help prevent asymmetrical power distributiou in the core. It helps to maintain adequate reactor water level into the core.

- **Top Guide**, safety related, provides lateral support to the reactor core assembly and maintains proper spacing of the upper ends of the fuel assemblies.

- **Core Plate**, safety related provides structural support to the reactor core fuel assemblies.

- **Control Rod Guide Tubes**, safety-related provides lateral guidance to a control rod and vertical support for the four fuel assemblies surrounding the control rod.

- **Control Rod Drive Housing/ Stub Tube**, safety related internal component provides access into the reactor pressure vessel for control rod drive mechanism.

- **Shroud Support and Access Hole Covers**, safety-related, known shroud baffle plate carries the weight of the shroud, shroud head, steam seperators, peripheral fuel assemblies, core plate, and top guide.

CAN has been unable to ascertain whether any testing or inspections have been accomplished in reference to the ISCC phenomena outside of VY's ten year inspection cycle program on these components. NRC Project Manger Dorman stated that these components had not been checked at this refueling. NRC Resident Inspector Eichenholtz was unable to give any details of the ten year plan. We believe these systems merit increased attention given the corrosive cracking of the shroud.

At Maine Yankee 360 cracks were indicated in tubes in the steam generators. However, with the use of the plus point probe, a more sensitive instrument, half of the tubes (8,000) were found to be flawed. Zetec, the maker of the plus point probe has developed the super probe which is used in PWRs. Could this system be used in BWR's such as VY to identify cracking?

We are therefore asking your panel to support:

- A request that the NRC provide the data to demonstrate certainty that the growth rate in the deterioration of the shroud and the 25 component systems will not proceed to failure before the next refueling outage.

- A mid-fueling inspection to examine these 25 component systems and the shroud itself.

- A Hearing with the Nuclear Regulatory Commission in attendance to explain to the community in Vermont and Massachusetts the problems with Core Shroud Corrosion Cracking and the 25 component systems before the next refueling cycle in order to clarify and demonstrate a review of the safety issues arising from the cracked shroud.

- A hearing after the next inspection, to inform the public in Vermont and Massachusetts of what information was ascertained and the extent of the deterioration of the systems and the shroud.

Respectfully Submitted,

Deborah Katz
President
Citizens Awareness Network

This is from NIRS... a list of 25 components affected by core shroud cracking that were not inspected/checked

PARTS LISTED AS INSPECTED DURING FALL 1994 OYSTER CREEK (N) REFUELING
(from NRC Inspection Report, Memo to file, Dated 950128; as taken from Telcon USNRC and GPUN dated 950119)

NIRS comments have been incorporated in italics.

=COMPONENT=	=NRC COMMENT=
CORE SPRAY SPARGER	("Previous Experience Intergranular Stress Corrosion Cracking [IGSCC]" "OK")

-Made of Type 304 stainless steel.
-Safety-related Internal
-Two circular headers at different elevations with two tee box pipe sections which inject cooling water into the core in the event of a Loss of Coolant Accident to prevent the fuel cladding from melting.
-According to a GPUN special report to NRC (Nov. 3, 1994) presenting results of inspections of the core spray sparger for the Cycle 15 refueling outage, the "Previous experience" of cracking of the Oyster Creek core spray sparger was first identified in 1978 as "one through wall crack" in core spray sparger with air release observed from a single 208 degree crack. The report documents 28 additionally cracks identified in the core spray sparger 1980, and 5 identified in 1982. Repair brackets were installed.
-Cracks in the core spray spargers can potentially alter the flow of coolant to the core and might lead to the generation of loose parts in the reactor pressure vessel.
-NRC Information Notice 80-14 (Ref. 4), addresses problems and outlines inspection requirements.

CORE SPRAY ANNULUS PIPING ("Weld Blowout Hole" "Acceptable As Is")

-Made of Type 304 stainless steel.
-Safety-related Internal
-The core spray annulus or core spray line internal piping is a component of the core spray system which supplies cooling water to the reactor fuel assemblies during a Loss of Coolant Accident to prevent the fuel cladding from melting. The core spray line connects the external core spray piping to the core spray spargers.
-According to GPUN special report to NRC (Nov. 3, 1994) presenting the results of inspections of the core spray annulus piping for the Cycle 15 refueling outage, the "Previous experience" of cracking of the spray line piping was first observed in 1980 as "two indications." The report documents an additional 3 indications ("one through weld hole" and "2-linear") were identified in 1992 where "Air release from Weld L-3A is continuous."

STEAM SEPARATOR ("Bracket Crack" "Accepted As Is")

-Made of Type 304 stainless steel
-Separates water droplets from steam generated in the core
-129 standpipes, also Type 304, welded to openings in the shroud head

STEAM DRYER ("Dryer Bracket Cracking" "Slwp Drilled Fatigue")

-Made of Type 304 stainless steel
-Removes excess moisture in steam exiting the steam separators
-During the R13 outage a crack was identified in the steam dryer bracket. As a result of high radiation emissions from the component (5 rem/hr), GPUN undertook an underwater crack mitigation effort in the equipment storage pool by plasma cutting 1/2 inch holes at each tip of the crack.

SHROUD HEAD BOLTS ("Previous Experience Replaced Due to IGSCC" "OK")

-Made of Inconnel 600 alloy, also susceptible to IGSCC
-Fastens shroud head to core shroud top flange.

CORE SUPPORT PLATE HOLD DOWN BOLTS ("OK")

BRACKETS for: ("Rent / Tear" "OK As Is")
GUIDE BOLTS
SPECIMEN HOLDER

EEDWATER SPARGER ("Keeper Bolt Tack Weld Crack" "OK As Is")

-Made of Type 316L and 316NG stainless steel.
-Safety-related reactor internal component.
-Under normal operation, feedwater sparger provides subcooling, homogenous and uniform temperature mixing to help prevent asymmetrical power distribution in the core. During a LOCA, the feedwater sparger becomes part of the High-Pressure Coolant Injection (HPCI) System to maintain an adequate reactor water level into the core.
-GPUN identified a crack in the keeper bolt on the feedwater sparger during R13. The crack was tack welded.
-During 1972, large circumferential cracks were detected in a feedwater sparger in other BWRs and were attributed to flow induced vibrations.

OP GUIDE ("Three Cracks Midspan" "OK As Is"
"Three Previous Cracks No Measurable Growth)

-Made of Type 304 stainless steel
-Safety related component
-Provides lateral support to the reactor fuel core assembly and maintains proper spacing of the upper ends of the fuel assemblies.
-In a report to NRC, General Public Utility Nuclear identified structural cracking of the top guide in August 1991. However, NRC officials responsible for the materials analysis and evaluation of Oyster Creek reactor internals claimed to only recently have been aware of the

-General Electric issued a service alert (RICSIL 071) in November 1994 advising all Boiling Water Reactor operators to inspect top guides and core plates for cracking after significant cracking was noted on these components in the Wuergassen BWR in Germany.
-The degree of inspection of the top guide is in question. NIRS believes that only the top guide ring was inspected while a lattice of intersecting steel beams welded together and to a circular rim may not have been inspected. Each square opening formed by the intersecting beams provides lateral support and maintains proper spacing for four fuel assemblies.

IN-CORE NEUTRON FLUX MONITOR HOUSING/
INTERMEDIATE RANGE MONITOR /
SOURCE RANGE MONITOR /
LOCAL POWER RANGE MONITOR ("IGSCC Cracking ReplaceableComponent")

-The housings are made of Type 304 stainless steel.
-The incore neutron flux monitor housing provides a penetration path for insertion of monitors into the reactor pressure vessel.

CORE SHROUD ("Significant Cracking In H4 Weld" "Permanent Repair Installed")

-The shroud is a segmented cylindrical steel structure made of Type 304 stainless steel and welded together.
-Safety-related internal component
-Provides lateral restraint to the reactor core, provides a refloodable compartment in the event of a Loss Of Coolant Accident, and provides for coolant water flow to the core. Because the shroud connects to the core plate at the bottom of the reactor core assembly with the top guide plate at the top of the reactor core assembly, any lateral shift resulting from a through wall break of a circumferential weld of the shroud outside of a tolerance of one eighth of an inch would prevent the full insertion of the control rods.
-Extensive cracking was identified on the H4 weld, approximately the midriff of the shroud. Contrary to industry experience to date, most shroud cracking has been noted at the upper and lower level welds of the shroud.
-GPUN completed a "permanent repair" utilizing 10 tie rods attached to the top and bottom of the core shroud assembly to prevent lateral motion.. [Note: bottom portion of the "fix" is hooked into plasma arc cut holes in plates of Type 304 welded to the shroud as part of the original design. Vulnerable to IGSCC]
-The Boiling Water Reactor Owners Group has identified that cracking on the core shroud is an indicator of cracking that could be occurring to other safety related reactor internals.
-One of the original reactors to show signs of shroud cracking, the Wuergassen BWR, Germany, was not allowed by the German nuclear regulator to install a "fix". Instead Wuergassen has undertaken to commence a two year outage and replacement of the shroud at an estimated cost of as much as $65 million.

SHROUD BRACKETS ("Minor Indication In Shroud To Bracket Weld" "OK")

-Oyster Creek is the only plant that has shroud brackets.

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PARTS NOT INDICATED AS INSPECTED during the R15 outage though identified as safety-related components and vulnerable to Stress Corrosion Cracking (SCC) in "Boiling Water Reactor Internals Aging Degradation Study" (NUREG/CR-5754), prepared for NRC by Oak Ridge National Laboratory, September, 1993 and Boiling Water Reactor Owners Group Meeting with NRC, June 28, 1994. These components are subject to regulations under American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code, Appendix 1, Section III.

CORE PLATE

-Made of Type 304 stainless steel
-Safety-related internal component
-Located at the bottom of the reactor core assembly, the core plate provides structural support to the reactor core fuel assemblies and perforations in the plate provide guidance to control rod guide tubes.
-A GE service alert (RICSIL 071) advised BWR operators to inspect the core plate after seeing extensive cracking of the core plate at Wuergassen, Germany.
-Oyster Creek passed over this inspection because the component was "inaccessible."

CONTROL ROD GUIDE TUBES

-Made of Type 304 stainless steel
-Safety-related component
-Provides lateral guidance to a control rod and vertical support for the four fuel assemblies surrounding that control rod. Extends up from the control rod drive housing and through the holes in the core plate.

CONTROL ROD DRIVE HOUSING/ STUB TUBE

-Made of Type 304 stainless steel
-Safety-related internal component
-Provides access into the reactor pressure vessel for control rod drive mechanism.
-Stub tubes are part of the reactor pressure vessel on older model BWRs.
-Leakage has been detected in the gap between the reactor pressure vessel and the Control Rod Drive Housing in other BWR s.

CONTROL BLADE

-Made of Type 304 stainless steel
-Provides for reactor core reactivity control

SHROUD HEAD

-Made of Type 304 stainless steel
-Provides structural support to the steam separators
-Attached to the top of the core shroud
-Steam separator standpipes welded to openings in the shroud head

SHROUD SUPPORT AND ACCESS HOLE COVERS

-The access hole cover is made of Alloy 600 (susceptible to IGSCC).
-Safety-related internal component
-The shroud support, also known as the shroud baffle plate, carries the weight of the shroud, shroud head, steam separators, peripheral fuel assemblies, core plate, and top guide.
It provides lateral support to the fuel assemblies. An annular plate with other edge welded to the reactor pressure vessel and the inner edge welded to the shroud.
-The Access Hole Covers or manway covers are circular steel plates which are put into two access holes, 180 degrees apart, between the vessel wall and the shroud.
-Through-wall-cracking in the weld of the access hole cover can jeopardize refloodability of the core by creating an alternate flowpath to bypass the core during normal and accident conditions. Failure of the access hole cover weld to the shroud support could result in a severed hole cover being swept up by flowpath into the recirculation pump suction line, causing damage to the pump.

ORFICED FUEL SUPPORT (OFS) PIECE

-The standard OFS piece is cast from Grade CF-3 or CF-8 steel. The peripheral OFS is made of Type 304 stainless steel.
-Provides lateral support and alignment to the fuel assemblies as well as distributing cooling water to them through an orifice. The weight of the fuel assemblies is transferred to the control rod drive tubes through the OFS piece.

VESSEL HEAD SPRAY COOLING NOZZLE (same as "reactor vessel nozzle")

-Provides coolant flow control and heat transfer enhancement
-NRC Inspection Report No. 50-219/94-20 identified weakness in GPUN oversight of contractor activity with regard to the reactor vessel nozzle inspection "because the contractor had a good reputation."

LPCI COUPLING

DIFFERENTIAL PRESSURE AND LIQUID CONTROL LINE

-Provides coolant flow control and heat transfer enhancement

JET PUMP ASSEMBLY

-Made of Type 304 stainless steel
-Safety-related reactor internal component
-Assembly pumps provide coolant flow for force convection heat transfer in the reactor
-They are used beginning with BWR-3 designs. Located in two semicircular groups between the core shroud and the RPV wall.

JET PUMP BEAMS

-Made of Type 304 stainless steel and alloy 600.
-Safety-related reactor internal component
-Holddown beams for the jet pump assembly

JET RISER BRACE

FUEL SUPPORT ASSEMBLY

PUBLIC

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VERMONT STATE NUCLEAR ADVISORY PANEL

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CITIZEN AWARENESS NETWORK Box 83 Shelburne Falls, MA 01370

Telephone 413-625-8881
Fax 413-339-6786

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- **Core Spray Annulus Piping**, safety related, this is a component of the Core Spray System which supplies cooling water to reactor fuel assemblies during a loss of Coolant Accident.

- **Feedwater Sparger**, safety-related, provides subcooling, homogenous and uniform temperature mixing to help prevent asymmetrical power distribution in the core. It helps to maintain adequate reactor water level into the core.

- **Top Guide**, safety related, provides lateral support to the reactor core assembly and maintains proper spacing of the upper ends of the fuel assemblies.

- **Core Plate**, safety related provides structural support to the reactor core fuel assemblies.

- **Control Rod Guide Tubes**, safety-related provides lateral guidance to a control rod and vertical support for the four fuel assemblies surrounding the control rod.

- **Control Rod Drive Housing/ Stub Tube**, safety related internal component provides access into the reactor pressure vessel for control rod drive mechanism.

- **Shroud Support and Access Hole Covers**, safety-related, known shroud baffle plate carries the weight of the shroud, shroud head, steam seperators, peripheral fuel assemblies, core plate, and top guide.

CAN has been unable to ascertain whether any testing or inspections have been accomplished in reference to the ISCC phenomena outside of VY's ten year inspection cycle program on these components. NRC Project Manger Dorman stated that these components had not been checked at this refueling. NRC Resident Inspector Eichenholtz was unable to give any details of the ten year plan. We believe these systems merit increased attention given the corrosive cracking of the shroud.

At Maine Yankee 360 cracks were indicated in tubes in the steam generators. However, with the use of the plus point probe, a more sensitive instrument, half of the tubes (8,000) were found to be flawed. Zetec, the maker of the plus point probe has developed the super probe which is used in PWRs. Could this system be used in BWR's such as VY to identify cracking?

We are therefore asking your panel to support:

- A request that the NRC provide the data to demonstrate certainty that the growth rate in the deterioration of the shroud and the 25 component systems will not proceed to failure before the next refueling outage.

- A mid-fueling inspection to examine these 25 component systems and the shroud itself.

- A Hearing with the Nuclear Regulatory Commission in attendance to explain to the community in Vermont and Massachusetts the problems with Core Shroud Corrosion Cracking and the 25 component systems before the next refueling cycle in order to clarify and demonstrate a review of the safety issues arising from the cracked shroud.

- A hearing after the next inspection, to inform the public in Vermont and Massachusetts of what information was ascertained and the extent of the deterioration of the systems and the shroud.

Respectfully Submitted,

Deborah Katz
President
Citizens Awareness Network

This is from NIRS... a list of 25 components affected by core shroud cracking that were not inspected/checked. Debbie

PARTS LISTED AS INSPECTED DURING FALL 1994 OYSTER CREEK (NJ) REFUELING
(from NRC Inspection Report, Memo to file, Dated 950128; as taken from Telcon USNRC and GPUN, dated 950119)

NIRS comments have been incorporated in italics.

=COMPONENT= **=(NRC COMMENT)=**

CORE SPRAY SPARGER ("Previous Experience Intergranular Stress Corrosion Cracking [IGSCC]" "OK")

-Made of Type 304 stainless steel.
-Safety-related internal
-Two circular headers at different elevations with two tee box pipe sections which inject cooling water into the core in the event of a Loss of Coolant Accident to prevent the fuel cladding from melting.
-According to a GPUN special report to NRC (Nov. 3, 1994) presenting results of inspections of the core spray sparger for the Cycle 15 refueling outage, the "Previous experience" of cracking of the Oyster Creek core spray sparger was first identified in 1978 as "one through wall crack" in core spray sparger with air release observed from a single 208 degree crack. The report documents 28 additionally cracks identified in the core spray sparger 1980, and 5 identified in 1982. Repair brackets were installed.
-Cracks in the core spray spargers can potentially alter the flow of coolant to the core and might lead to the generation of loose parts in the reactor pressure vessel.
-NRC Information Notice 80-14 (Ref. 4). addresses problems and outlines inspection requirements.

CORE SPRAY ANNULUS PIPING ("Weld Blowout Hole" "Acceptable As Is")

-Made of Type 304 stainless steel.
-Safety-related internal
-The core spray annulus or core spray line internal piping is a component of the core spray system which supplies cooling water to the reactor fuel assemblies during a Loss of Coolant Accident to prevent the fuel cladding from melting. The core spray line connects the external core spray piping to the core spray spargers.
-According to GPUN special report to NRC (Nov. 3, 1994) presenting the results of inspections of the core spray annulus piping for the Cycle 15 refueling outage, the "Previous experience" of cracking of the spray line piping was first observed in 1980 as "two indications." The report documents an additional 3 indications ("one through weld hole" and "2-linear") were identified in 1992 where "Air release from Weld L-3A is continuous."

STEAM SEPARATOR ("Bracket Crack" "Accepted As Is")

-Made of Type 304 stainless steel
-Separates water droplets from steam generated in the core
-129 standpipes, also Type 304, welded to openings in the shroud head

STEAM DRYER ("Dryer Bracket Cracking" "Slug Drilled Fatigue")

- *Made of Type 304 stainless steel*
- *Removes excess moisture in steam exiting the steam separators*
- *During the R15 outage a crack was identified in the steam dryer bracket. As a result of high radiation emissions from the component (3 rem/hr), GPUN undertook an underwater crack mitigation effort in the equipment storage pool by plasma cutting 1/2 inch holes at each tip of the crack.*

SHROUD HEAD BOLTS ("Previous Experience Replaced Due to IGSCC" "OK")

- *Made of Inconnel 600 alloy, also susceptible to IGSCC*
- *Fastens shroud head to core shroud top flange.*

CORE SUPPORT PLATE HOLD DOWN BOLTS ("OK")

BRACKETS for: ("Bent / Tear" "OK As Is")
GUIDE BOLTS
SPECIMEN HOLDER

FEEDWATER SPARGER ("Keeper Bolt Tack Weld Crack" "OK As Is")

- *Made of Type 316L and 316NG stainless steel.*
- *Safety-related reactor internal component.*
- *Under normal operation, feedwater sparger provides subcooling, homogenous and uniform temperature mixing to help prevent asymmetrical power distribution in the core. During a LOCA, the feedwater sparger becomes part of the High-Pressure Coolant Injection (HPCI) System to maintain an adequate reactor water level into the core.*
- *GPUN identified a crack in the keeper bolt on the feedwater sparger during R15. The crack was tack welded.*
- *During 1972, large circumferential cracks were detected in a feedwater sparger in other BWRs and were attributed to flow induced vibrations.*

TOP GUIDE ("Three Cracks Midspan" "OK As Is"
"Three Previous Cracks No Measurable Growth)

- *Made of Type 304 stainless steel*
- *Safety related component*
- *Provides lateral support to the reactor fuel core assembly and maintains proper spacing of the upper ends of the fuel assemblies.*
- *In a report to NRC, General Public Utility Nuclear identified structural cracking of the top guide in August 1991. However, NRC officials responsible for the materials analysis and evaluation of Oyster Creek reactor internals claimed to only recently have been aware of the*

-General Electric issued a service alert (RICSIL 071) in November 1994 advising all Boiling Water Reactor operators to inspect top guides and core plates for cracking after significant cracking was noted on these components in the Wuergassen BWR in Germany.
-The degree of inspection of the top guide is in question. NIRS believes that only the top guide ring was inspected while a lattice of intersecting steel beams welded together and to a circular rim may not have been inspected. Each square opening formed by the intersecting beams provides lateral support and maintains proper spacing for four fuel assemblies.

IN-CORE NEUTRON FLUX MONITOR HOUSING/
INTERMEDIATE RANGE MONITOR /
SOURCE RANGE MONITOR /
LOCAL POWER RANGE MONITOR ("IGSCC Cracking ReplaceableComponent")

-The housings are made of Type 304 stainless steel.
-The incore neutron flux monitor housing provides a penetration path for insertion of monitors into the reactor pressure vessel.

CORE SHROUD ("Significant Cracking in H4 Weld" "Permanent Repair Installed")

-The shroud is a segmented cylindrical steel structure made of Type 304 stainless steel and welded together.
-Safety-related internal component
-Provides lateral restraint to the reactor core, provides a refloodable compartment in the event of a Loss Of Coolant Accident, and provides for coolant water flow to the core. Because the shroud connects to the core plate at the bottom of the reactor core assembly with the top guide plate at the top of the reactor core assembly, any lateral shift resulting from a through wall break of a circumferential weld of the shroud outside of a tolerance of one eighth of an inch would prevent the full insertion of the control rods.
-Extensive cracking was identified on the H4 weld, approximately the midriff of the shroud. Contrary to industry experience to date, most shroud cracking has been noted at the upper and lower level welds of the shroud.
-GPUN completed a "permanent repair" utilizing 10 tie rods attached to the top and bottom of the core shroud assembly to prevent lateral motion.. [Note: bottom portion of the "fix" is hooked into plasma arc cut holes in plates of Type 304 welded to the shroud as part of the original design. Vulnerable to IGSCC]
-The Boiling Water Reactor Owners Group has identified that cracking on the core shroud is an indicator of cracking that could be occurring to other safety related reactor internals.
-One of the original reactors to show signs of shroud cracking, the Wuergassen BWR, Germany, was not allowed by the German nuclear regulator to install a "fix". Instead Wuergassen has undertaken to commence a two year outage and replacement of the shroud at an estimated cost of as much as $65 million.

SHROUD BRACKETS ("Minor Indication In Shroud To Bracket Weld" "OK")

-Oyster Creek is the only plant that has shroud brackets.

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PARTS NOT INDICATED AS INSPECTED during the R15 outage though identified as safety-related components and vulnerable to Stress Corrosion Cracking (SCC) in "Boiling Water Reactor Internals Aging Degradation Study" (NUREG/CR-5754), prepared for NRC by Oak Ridge National Laboratory, September, 1993 and Boiling Water Reactor Owners Group Meeting with NRC, June 28, 1994. These components are subject to regulations under American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code, Appendix 1, Section III.

CORE PLATE

- *Made of Type 304 stainless steel*
- *Safety-related internal component*
- *Located at the bottom of the reactor core assembly, the core plate provides structural support to the reactor core fuel assemblies and perforations in the plate provide guidance to control rod guide tubes.*
- *A GE service alert (RICSIL 071) advised BWR operators to inspect the core plate after seeing extensive cracking of the core plate at Wuergassen, Germany.*
- *Oyster Creek passed over this inspection because the component was "inaccessible."*

CONTROL ROD GUIDE TUBES

- *Made of Type 304 stainless steel*
- *Safety-related component*
- *Provides lateral guidance to a control rod and vertical support for the four fuel assemblies surrounding that control rod. Extends up from the control rod drive housing and through the holes in the core plate.*

CONTROL ROD DRIVE HOUSING/ STUB TUBE

- *Made of Type 304 stainless steel*
- *Safety-related internal component*
- *Provides access into the reactor pressure vessel for control rod drive mechanism.*
- *Stub tubes are part of the reactor pressure vessel on older model BWRs.*
- *Leakage has been detected in the gap between the reactor pressure vessel and the Control Rod Drive Housing in other BWR s.*

CONTROL BLADE

- *Made of Type 304 stainless steel*
- *Provides for reactor core reactivity control*

SHROUD HEAD

-Made of Type 304 stainless steel
-Provides structural support to the steam separators
-Attached to the top of the core shroud
-Steam separator standpipes welded to openings in the shroud head

SHROUD SUPPORT AND ACCESS HOLE COVERS

-The access hole cover is made of Alloy 600 (susceptible to IGSCC).
-Safety-related internal component
-The shroud support, also known as the shroud baffle plate, carries the weight of the shroud, shroud head, steam separators, peripheral fuel assemblies, core plate, and top guide.
It provides lateral support to the fuel assemblies. An annular plate with other edge welded to the reactor pressure vessel and the inner edge welded to the shroud.
-The Access Hole Covers or manway covers are circular steel plates which are put into two access holes, 180 degrees apart, between the vessel wall and the shroud.
-Through-wall-cracking in the weld of the access hole cover can jeopardize refloodability of the core by creating an alternate flowpath to bypass the core during normal and accident conditions. Failure of the access hole cover weld to the shroud support could result in a severed hole cover being swept up by flowpath into the recirculation pump suction line, causing damage to the pump.

ORFICED FUEL SUPPORT (OFS) PIECE

-The standard OFS piece is cast from Grade CF-3 or CF-8 steel. The peripheral OFS is made of Type 304 stainless steel.
-Provides lateral support and alignment to the fuel assemblies as well as distributing cooling water to them through an orifice. The weight of the fuel assemblies is transferred to the control rod drive tubes through the OFS piece.

VESSEL HEAD SPRAY COOLING NOZZLE (same as "reactor vessel nozzle")

-Provides coolant flow control and heat transfer enhancement
-NRC Inspection Report No. 50-219/94-20 identified weakness in GPUN oversight of contractor activity with regard to the reactor vessel nozzle inspection "because the contractor had a good reputation."

LPCI COUPLING

DIFFERENTIAL PRESSURE AND LIQUID CONTROL LINE

-Provides coolant flow control and heat transfer enhancement

JET PUMP ASSEMBLY

-Made of Type 304 stainless steel
-Safety-related reactor internal component
-Assembly pumps provide coolant flow for force convection heat transfer in the reactor
-They are used beginning with BWR-3 designs. Located in two semicircular groups between the core shroud and the RPV wall.

JET PUMP BEAMS

-Made of Type 304 stainless steel and alloy 600.
-Safety-related reactor internal component
-Holddown beams for the jet pump assembly

JET RISER BRACE

FUEL SUPPORT ASSEMBLY