Industry/TSTF Standard Technical Specification Change Traveler

Increase accumulator Completion Time from 1 hour to 24 hours

Classification: 3) Improve Specifications

NUREGs Affected: ☐ 1430 ☑ 1431 ☐ 1432 ☐ 1433 ☐ 1434

Description:

The Completion Time associated with Condition B in STS 3.5.1, "Accumulators," is revised from 1 hour to 24 hours. Condition B applies to one accumulator inoperable for reasons other than boron concentration not within limits.

Justification:

See attached justification

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Revision History

OG Revision 0 **Revision Status: Active** **Next Action: TSTF**

Revision Proposed by: WOG

Revision Description:
Original Issue

Owners Group Review Information

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Owners Group Comments
(No Comments)

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TSTF Review Information

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Incorporation Into the NUREGs

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Affected Technical Specifications

Ref. 3.5.1 Bases Accumulators

11/16/2000

Action 3.5.1.B	Accumulators
Action 3.5.1.B Bases	Accumulators
SR 3.5.1.4 Bases	Accumulators

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8) Justification of Change:

BACKGROUND

WCAP-15049, "Risk-Informed Evaluation of an Extension to Accumulator Completion Times," was submitted to the NRC on August 20, 1998 and approved in NRC letter dated February 19, 1999. The WCAP evaluates the risk associated with extending the accumulator Completion Time from one hour to 24 hours for reasons other than boron concentration out of specification.

Wolf Creek was the lead plant for the WOG program and received plant specific approval for changes to the Technical Specifications on April 27, 1999 (License Amendment No. 124). In the NRC letter of February 19, 1999, the staff indicates that it will not repeat its review of the matters described in WOG Topical Report WCAP-15049 when the report appears as a reference in license applications, except to ensure that the material presented applies to the specified plants involved.

NEED FOR CHANGE

The WOG requested this change because one hour is an insufficient amount of time to correct accumulator mechanical problems or to restore parameters within limits.

PROPOSED CHANGE:

The proposed change revises the Completion Time from 1 hour to 24 hours for Condition B of TS 3.5.1, "Accumulators," and the associated Bases. TS 3.5.1 Condition B currently specifies a Completion Time of one hour to restore a RCS accumulator to OPERABLE status when declared inoperable due to any reason except not being within the required boron concentration range.

JUSTIFICATION

Deterministic Evaluation

The purpose of the emergency core cooling system (ECCS) accumulators is to supply water to reactor vessel during the blowdown phase of a loss of coolant accident (LOCA). The accumulators are large volume tanks, filled with borated water and pressurized with nitrogen. The cover-pressure is less than that of the Reactor Coolant System so that following an accident, when Reactor Coolant System pressure decreases below tank pressure, the accumulators inject the borated water into the RCS cold legs. Currently, the TS allows for one accumulator to be inoperable for one hour for reasons other than boron concentration not within limits during MODES 1, 2, and in MODE 3 with pressurizer pressure > a plant specific pressure. The WCAP proposes to increase this CT to 24 hours. This proposed allowed outage time of 24 hours is an extension of the current ACTION statement and has no impact on the safety analysis. Therefore, the current safety analysis remains valid, and it is concluded that there is no difference in the deterministic safety significance of a one hour CT for one accumulator and a 24-hour CT. The difference in the current TS versus the proposed extension lies in the added risk due to the extension of the AOT which is reviewed in the following section of this evaluation.

Risk Evaluation

A three-tiered approach, consistent with RG 1.177[2], was used by the staff to evaluate the risk associated with the proposed accumulator CT, or allowed outage time (AOT), extension from one hour to 24 hours. The need for the proposed change

[2] RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," September 1998

was that the current one-hour CT would be insufficient in most cases for licensees to take a reasonable action when an accumulator was found to be inoperable.

Tier 1: Quality of Probabilistic Risk Assessment (PRA) and Risk Impact

Westinghouse used a reasonable approach to assess the risk impact of the proposed accumulator CT extension. The approach is generally consistent with the intent of the applicable NRC Regulatory Guides 1.174[3] and RG 1.177. The quantitative risk measures addressed in the topical report included the change in core damage frequency (CDF) and incremental conditional core damage probability (ICCDP[4]) for a single CT. The change in large early release frequency (LERF) and incremental conditional large early probability (ICLERP[5]) for a single CT were qualitatively addressed. Representative calculations were performed to determine the risk impact of the proposed change. Various accumulator success criteria were considered in these calculations to encompass the whole spectrum of Westinghouse plants, e.g., two-, three- and four-loop plants. A reasonable effort was also made to address the differences in other components of risk analysis such as initiating event (IE) frequency and accumulator unavailability among Westinghouse plants.

Westinghouse considered a comprehensive range of IEs in the risk analysis. Loss of coolant accidents (LOCAs) in all sizes - large, medium and small - were included, and reactor vessel failure and interfacing system LOCA were also considered. Modeling of accumulators for mitigation of events other than large, medium and small LOCAs was identified to have insignificant risk impact; therefore, the analysis was performed only on accumulator injection in response to large, medium and small LOCA events.

The success criteria considered are summarized as follows:

LOCA Category	No. of Loops	Success Criteria
Large	4	3 accumulators to 3 of 3 intact loops (3/3) 2 accumulators to 2 of 3 intact loops (2/3) no accumulators required (0/3)
	3	2 accumulators to 2 of 2 intact loops (2/2) 1 accumulators to 1 of 2 intact loops (1/2) no accumulators required (0/2)
	2	1 accumulator to 1 of 1 intact loop (1/1) no accumulators required (0/1)
Medium and Small	4	3 accumulators to 3 of 3 intact loops (3/3)
	3	2 accumulators to 2 of 2 intact loops (2/2)
	2	1 accumulator to 1 of 1 intact loop (1/1)

The success criteria considered in this analysis were comprehensive and considered conservative in many cases. For example, many plants indicated the accumulator success criteria for medium and small LOCA events were associated with alternate success path, in which high pressure injection (HPI) had already failed. Additionally, the staff review of a number

[3] RG1 174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998

[4] ICCDP = [(conditional CDF with the subject equipment out of service) – (baseline CDF with nominal expected equipment unavailabilities) x (duration of single CT under consideration)]

[5] ICLERP = [(conditional LERF with the subject equipment out of service) - (baseline LERF with nominal expected equipment unavailabilities) x (duration of single CT under consideration)]

of the original IPEs indicated that no accumulator was needed at all for many medium LOCA sequences and for most of small LOCA sequences.

The fault trees that model accumulator unavailabilities were evaluated. The assumptions made in the fault tree modeling were detailed, and were found to be reasonable. For example, the model assumed that the total CT would be used for each corrective maintenance, and this was considered conservative. A comprehensive list of failure mechanisms were considered, and potential common cause failures for check valves and motor-operated valves were also included. Westinghouse used the Multiple Greek Letter technique to determine the common cause failure contributions to the accumulator injection failure.

The component failure rates were taken from the Advanced Light Water Utility Requirements Document.[6] Accumulator unavailabilities due to Boron concentration out of limit and due to other reasons were calculated based on a survey of a number of Westinghouse plants. The values for component failure rates and accumulator unavailabilities were within reasonable range. The common cause factors used were also comparable to those used in other PRAs. The accumulator fault trees were quantified using the WesSAGE Computer Code. The code provided information on the unavailability and cutsets related to the component failures and maintenance activities modeled in the fault trees. A separate hand calculation was used to determine the unavailability due to potential common cause failures. Evaluation of some of the cutsets provided in the topical report did not reveal any unexpected results.

The staff examined the accident sequence identification for each LOCA category. The probability of the sequence leading to core damage involving accumulator failure is summarized for each LOCA category as follows:

Large LOCA	(Large LOCA IE frequency) x (accumulator unavailability)
Medium LOCA	(Medium LOCA IE frequency) x (unavailability of HPI) x (accumulator unavailability)
Small LOCA	(Small LOCA IE frequency) x (unavailability of HPI) x (accumulator unavailability)

The LOCA IE frequencies used for WCAP-15049 are summarized below. Also listed are the LOCA frequencies used in NUREG/CR-4550[7] (the NUREG-1150 study) for pressurized water reactors (PWRs) and those in the original IPEs.

	WCAP-15049	NUREG-1150	IPE Average (High; Low)
Large LOCA	3×10^{-4}/yr	5×10^{-4}/yr	3.3×10^{-4}/yr (5×10^{-4}/yr; 1×10^{-5}/yr)
Medium LOCA	8×10^{-4}/yr	1×10^{-3}/yr	7.9×10^{-4}/yr (2.6×10^{-3}/yr; 1×10^{-4}/yr)
Small LOCA	7×10^{-3}/yr	1×10^{-3}/yr	8.9×10^{-3}/yr (2.9×10^{-2}/yr; 3.7×10^{-4}/yr)

Westinghouse indicated that the IE frequencies for WCAP-15049 were based on the plantspecific information contained in the Westinghouse Owners Group (WOG) PSA Comparison Database, which documented the PRA modeling methods and results of the updated PRAs for Westinghouse plants. The mean IE frequencies were used for the risk analysis. These were comparable to the values used for the NUREG-1150 study and the average values in the original IPEs. The staff also found that the IE frequency values in high range among the original IPEs were not much higher than those used for this topical

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[6] "Advanced Light Water Utility Requirements Document." Volume II, ALWR Evolutionary Plant. Chapter 1, Appendix A, PRA Key Assumptions and Ground Rules, Rev. 5. Issued December, 1992

[7] NUREG/CR-4550, "Analysis of Core Damage Frequency: Internal Events Methodology," Vol. 1, Rev. 1, January 1990

report. The HPI unavailability values used were $7x10^{-3}$ and $1x10^{-3}$/yr for medium and small LOCA events, respectively. The staff's examination revealed that the HPI unavailability values were generally comparable to those used in other PRAs, and were generally conservative.

The risk measures calculated to determine the impact on plant risk were based on three different cases. The risk measures considered in each case included the impact on CDF and ICCDP for a single CT, and the impact on LERF and ICLERP for a single CT were qualitatively considered. The three cases considered were:

Design basis case: This case required accumulator injection only for mitigation of large LOCA events (3/3 for 4-loop, 21/2 for 3-loop, and 1/1 for 2-loop).

Case 1: This case credited realistic accumulator success criteria (2/3 for 4-loop, 1/2 for 3-loop, and 0/1 for 2-loop) for large LOCA events and credited the use of accumulators in responding to medium and small LOCA events (3/3, 2/2, and 1/1 for 4-loop, 3-loop, and 2-loop, respectively) following failure of HPI

Case 2: This case credited more realistic improved accumulator success criteria (no accumulator required) for large LOCA events and credited the use of accumulators in responding to medium and small LOCA events (3/3, 2/2, and 1/1 for 4-loop, 3-loop, and 2-loop, respectively) following failure of HPI.

The results were summarized as follows:

Case	LOCA CDF(/yr) (Current)	LOCA CDF(/yr) (Proposed)	?CDF	ICCDP
4-loop Design Basis	$6.93x10^{-7}$	$9.24x10^{-7}$	$2.31x10^{-7}$	$8.20x10^{-7}$
4-loop Case 1	$6.23x10^{-8}$	$7.77x10^{-8}$	$1.54x10^{-8}$	$5.53x10^{-8}$
4-loop Case 2	$4.57x10^{-8}$	$6.09x10^{-8}$	$1.52x10^{-8}$	$5.41x10^{-8}$
3-loop Design Basis	$4.62x10^{-7}$	$6.18x10^{-7}$	$1.56x10^{-7}$	$8.21x10^{-7}$
3-loop Case 1	$4.27x10^{-8}$	$5.31x10^{-8}$	$1.04x10^{-8}$	$5.48x10^{-8}$
3-loop Case 2	$3.05x10^{-8}$	$4.08x10^{-8}$	$1.03x10^{-8}$	$5.42x10^{-8}$
2-loop Design Basis	$2.31x10^{-7}$	$3.09x10^{-7}$	$7.80x10^{-8}$	$8.21x10^{-7}$
2-loop Case 1	$1.52x10^{-8}$	$2.04x10^{-8}$	$5.20x10^{-9}$	$5.42x10^{-8}$
2-loop Case 2	$1.52x10^{-8}$	$2.04x10^{-8}$	$5.20x10^{-9}$	$5.42x10^{-8}$

For both realistic cases, the ?CDFs and ICCDPs were very small for 2-loop, 3-loop, and 4-loop plants, and were much below the numerical guidelines in the RG 1.174 and 1.177. The staff also noted that the values were considered still bounding in the sense that the risk analysis used a multitude of conservative assumptions and data in the modeling. For many Westinghouse plants, the realistic impact on risk would be much smaller than the values above.

A set of sensitivity cases were also calculated using higher IE frequencies for small and medium LOCAs. The results of the sensitivity calculations did not cause the overall risk impact to increase significantly.

Westinghouse indicated that accumulator success or failure has no direct impact on the containment performance, and that the LERF would therefore increase only in direct proportion to the increased CDF due to accumulator failures. Westinghouse concluded that, since the impact on CDF was small, the impact on LERF would also be small. The staff

found the Westinghouse argument to be acceptable; therefore, the impact on LERF and ICLERP for a single CT was very small.

One of the potential benefits of the proposed extended CT was the averted risk associated with avoiding a forced plant shutdown and startup. The risk associated with a forced plant shutdown and ensuing startup due to the inflexibility in current TS could be significant in comparison with the risk increase due to the proposed accumulator CT increase.

Based on the staff's Tier 1 review, the quality of risk analysis used to calculate the risk impact of the proposed accumulator CT extension was reasonable and generally conservative. It was also found that the risk impact of the proposed change was below the staff guidelines in RG 1.174 and RG 1.177.

Tier 2 and 3: Configuration Risk Control

The Tier 2 evaluation did not identify the need for any additional constraints or compensatory actions that, if implemented, would avoid or reduce the probability of a risk-significant configuration. The current TS provisions were found to be sufficient to address the Tier 2 issue. Because the accumulator sequence modeling is relatively independent of the that for other systems, the staff concluded that application of Tier 3 to the proposed accumulator CT was not necessary.

DETERMINATION OF NO SIGNIFICANT HAZARDS CONSIDERATION

In accordance with the criteria set forth in 10 CFR 50.92, the proposed changes to NUREG-1431 have been evaluated and determined they do not represent a significant hazards consideration. The following is provided in support of this conclusion:

Standard I - Involves a Significant Increase in the Probability or Consequences of an Accident Previously Evaluated

The proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated. The impact of the increase in the accumulator AOT on core damage frequency for all the cases evaluated in WCAP-15049 is within the acceptance limit of 1.0E-06/yr for a total plant CDF less than 1.0E-03/yr. The incremental conditional core damage probabilities calculated in WCAP-15049 for the accumulator AOT increase meet the criterion of 5E-07 in Regulatory Guide DG-1065 for all cases except those that are based on design basis success criteria. As indicated in WCAP-15049, design basis accumulator success criteria are not considered necessary to mitigate large break LOCA events, and was only included in the WCAP-15049 evaluation as a worst case data point. In addition, WCAP-15049 states that the NRC has indicated that an ICCDP greater than 5E-07 does not necessarily mean the change is unacceptable.

The safety injection accumulators are credited in the accident analysis for a large and small break LOCA. There will be no effect on these analyses, or any other accident analysis, since the analysis assumptions are unaffected. Design basis accidents are not assumed to occur during allowed outage times covered by the Technical Specifications. As such, the ECCS Evaluation Model equipment availability assumptions remain valid.

The safety injection accumulators will continue to function in a manner consistent with the above analysis assumptions and the plant design basis. As such, there will be no degradation in the performance of, nor an increase in the number of challenges to, equipment assumed to function during an accident situation.

The proposed technical specification change does not involve any hardware changes nor does it affect the probability of any event initiators. There will be no change to normal plant operating parameters, engineered safety feature (ESF) actuation setpoints, accident mitigation capabilities, accident analysis assumptions or inputs. Therefore, this change will not increase the probability of an accident or malfunction.

The corresponding increase in CDF due to the proposed change to increase the AOT of the accumulators from one hour to 24 hours is not significant. Pursuant to the guidance in Section 3.5 of NEI 96-07, Revision 0, "Guidelines for 10 CFR 50.59 Safety Evaluations," the proposed increase in AOT does not "degrade below the design basis the performance of a safety system assumed to function in the accident analysis," nor does it "increase challenges to safety systems assumed to function in the accident analysis such that safety system performance is degraded below the design basis without compensating effects." Therefore, it is concluded that this change does not increase the probability of occurrence of a malfunction of equipment important to safety.

Standard II - Create the Possibility of a New or Different Kind of Accident from any Previously Evaluated

No new accident scenarios, transient precursors, failure mechanisms, or limiting single failures are introduced as a result of the proposed change. As described in Section 9.1 of the WCAP-15049 evaluation, the plant design will not be changed with this proposed Technical Specification AOT increase. All safety systems still function in the same manner and there is no additional reliance on additional systems or procedures. The proposed accumulator AOT increase has a very small impact on core damage frequency. The WCAP-15049 evaluation demonstrates that the small increase in risk due to increasing the accumulator AOT is within the acceptance criteria provided in Draft Regulatory Guide DG-1065. No new accident or transients can be introduced with the requested change and the likelihood of an accident or transient is not impacted.

The malfunction of safety related equipment, assumed to be operable in the accident analyses, would not be caused as a result of the proposed technical specification change. No new failure mode has been created and no new equipment performance burdens are imposed. Therefore, the possibility of a new or different malfunction of safety related equipment is not created.

Standard III - Involve a Significant Reduction in the Margin of Safety

The proposed change does not involve a significant reduction in a margin of safety. There will be no change to the Departure from Nucleate Boiling Ratio (DNBR) Correlation Limit, the design DNBR limits, or the safety analysis DNBR limits.

The basis for the accumulator LCO, as discussed in Bases Section 3.5.1, is to ensure that a sufficient volume of borated water will be immediately forced into the core through each of the cold legs in the event the RCS pressure falls below the pressure of the accumulators, thereby providing the initial cooling mechanism during large RCS pipe ruptures. As described in Section 9.2 of the WCAP-15049 evaluation, the proposed change will allow plant operation in a configuration outside the design basis for up to 24 hours, instead of 1 hour, before being required to begin shutdown. The impact of this on plant risk was evaluated and found to be very small. That is, increasing the time the accumulators will be unavailable to respond to a large LOCA event, assuming design basis accumulator success criteria is necessary to mitigate the event, has a very small impact on plant risk. Since the frequency of a design basis large LOCA (a large LOCA with loss of offsite power) would be significantly lower than the large LOCA frequency of the WCAP-15049 evaluation, the impact of increasing the accumulator AOT from 1 hour to 24 hours on plant risk due to a design basis large LOCA would be significantly less than the plant risk increase presented in the WCAP-15049 evaluation. It is therefore concluded that the proposed change does not involve a significant reduction in the margin of safety as described in Technical Specification Bases Section 3.5.1.

As discussed previously, the performance of the accumulators will remain within the assumptions used in the large and small break LOCA analyses. Also, there will be no effect on the manner in which safety limits or limiting safety system settings are determined nor will there be any effect on those plant systems necessary to assure the accomplishment of protection functions.

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3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.1 Accumulators

LCO 3.5.1 [Four] ECCS accumulators shall be OPERABLE.

APPLICABILITY: MODES 1 and 2,
MODE 3 with pressurizer pressure > [1000] psig.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One accumulator inoperable due to boron concentration not within limits.	A.1	Restore boron concentration to within limits.	72 hours
B. One accumulator inoperable for reasons other than Condition A.	B.1	Restore accumulator to OPERABLE status.	~~1~~ 24 hour 5
C. Required Action and associated Completion Time of Condition A or B not met.	C.1	Be in MODE 3.	6 hours
	AND		
	C.2	Reduce pressurizer pressure to ≤ [1000] psig.	12 hours
D. Two or more accumulators inoperable.	D.1	Enter LCO 3.0.3.	Immediately

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BASES

ACTIONS

A.1 (continued)

reduced. The boron in the accumulators contributes to the assumption that the combined ECCS water in the partially recovered core during the early reflooding phase of a large break LOCA is sufficient to keep that portion of the core subcritical. One accumulator below the minimum boron concentration limit, however, will have no effect on available ECCS water and an insignificant effect on core subcriticality during reflood. Boiling of ECCS water in the core during reflood concentrates boron in the saturated liquid that remains in the core. In addition, current analysis techniques demonstrate that the accumulators do not discharge following a large main steam line break for the majority of plants. Even if they do discharge, their impact is minor and not a design limiting event. Thus, 72 hours is allowed to return the boron concentration to within limits.

B.1

If one accumulator is inoperable for a reason other than boron concentration, the accumulator must be returned to OPERABLE status within 1 hour. In this Condition, the required contents of three accumulators cannot be assumed to reach the core during a LOCA. Due to the severity of the consequences should a LOCA occur in these conditions, the 1 hour Completion Time to open the valve, remove power to the valve, or restore the proper water volume or nitrogen cover pressure ensures that prompt action will be taken to return the inoperable accumulator to OPERABLE status. The Completion Time minimizes the potential for exposure of the plant to a LOCA under these conditions.

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C.1 and C.2

If the accumulator cannot be returned to OPERABLE status within the associated Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to MODE 3 within 6 hours and pressurizer pressure reduced to

The 24 hours allowed to restore an inoperable accumulator to OPERABLE status is justified in WCAP-15049-A, Rev. 1 (Ref. 5).

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BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.5.1.4

The boron concentration should be verified to be within required limits for each accumulator every 31 days since the static design of the accumulators limits the ways in which the concentration can be changed. The 31 day Frequency is adequate to identify changes that could occur from mechanisms such as stratification or inleakage. Sampling the affected accumulator within 6 hours after a 1% volume increase will identify whether inleakage has caused a reduction in boron concentration to below the required limit. It is not necessary to verify boron concentration if the added water inventory is from the refueling water storage tank (RWST), because the water contained in the RWST is within the accumulator boron concentration requirements. This is consistent with the recommendation of NUREG-1366 (Ref. ~~8~~ 6).

SR 3.5.1.5

Verification every 31 days that power is removed from each accumulator isolation valve operator when the pressurizer pressure is ≥ 2000 psig ensures that an active failure could not result in the undetected closure of an accumulator motor operated isolation valve. If this were to occur, only two accumulators would be available for injection given a single failure coincident with a LOCA. Since power is removed under administrative control, the 31 day Frequency will provide adequate assurance that power is removed.

This SR allows power to be supplied to the motor operated isolation valves when pressurizer pressure is < 2000 psig, thus allowing operational flexibility by avoiding unnecessary delays to manipulate the breakers during plant startups or shutdowns. Even with power supplied to the valves, inadvertent closure is prevented by the RCS pressure interlock associated with the valves.

Should closure of a valve occur in spite of the interlock, the SI signal provided to the valves would open a closed valve in the event of a LOCA.

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BASES (continued)

REFERENCES

1. IEEE Standard 279-1971.
2. FSAR, Chapter [6].
3. 10 CFR 50.46.
4. FSAR, Chapter [15].
5. NUREG-1366, February 1990.
6. 5. WCAP-15049-A, Rev. 1, April 1999.