Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690 - 0767

July 1, 1987

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Zion Nuclear Power Station
Units 1 and 2
Annual FSAR Update
NRC Docket Nos. 50-295 & 50-304

Gentlemen:

10CFR 50.71.e sets forth the requirements for periodically updating each station's FSAR. The attachment to this letter contains revised pages for Zion Station's FSAR to reflect changes made pursuant to 10CFR50.59 for the period between January 1, 1986 and December 31, 1986. The attached changes are due to alterations in the technical specification limit on Nuclear Heat Flux Hot Channel Factor (Fnq), the PP Nitrogen Supply System, the formula for the over temperature delta T and over power delta t trip setpoints, noise reduction measures on the source Range NIS, Corrections to the description of the Waste Gas Analyzer, and setpoint changes regarding the Negative Flux rate trip.

If any further questions arise regarding this matter please direct them to this office.

Very truly yours,

Peter LeBlond
P. C. LeBlond
Nuclear Licensing Administrator

Attachment

cc: Resident Inspector - Zion
J. A. Norris - NRR

8707080480 870701
PDR ADOCK 05000295
P PDR

3269K

A053
1/1

1987 ZION STATION

SAFETY ANALYSIS REPORT UPDATE

Change	Page
Nuclear Heat Flux Hot Channel Factor (F_Q^N)	3.1-7
Nitrogen Supply to PP System	6.6-9, 6.6-10
OTΔT and OPΔT Setpoint Definition	7.2-18, 7.2-19
Source Range Preamplifier Noise Reduction	7.4-6
Negative Flux Rate Trip (NFRT) Setpoint	7.4-13
Waste Gas Analyzer	11.1-19, 11.1-20, 11.1-44

11440

Limits, which include considerable margin, are placed on the maximum reactivity worth of control rods or elements and on rates at which reactivity can be increased to ensure that the potential effects of a sudden or large change of reactivity cannot (a) rupture the reactor coolant pressure boundary or (b) disrupt the core, its support structures, or other vessel internals so as to lose capability to cool the core.

The reactor control system employs control rod clusters. A portion of these are designated shutdown rods and are fully withdrawn during power operation. The remaining rods comprise the control groups which are used to control load and reactor coolant temperature. The rod cluster drive mechanisms are wired into preselected groups, and are therefore prevented from being withdrawn in other than their respective groups. The rod drive mechanism is of the magnetic latch type and the coil actuation is sequenced to provide variable speed rod travel. The maximum reactivity insertion rate is analyzed in the setpoint study assuming two of the highest worth groups to be accidentally withdrawn at maximum speed yielding reactivity insertion rates of the order of 8×10^{-4} Δk/sec which is well within the capability of the overpower-overtemperature protection circuits to prevent core damage. To ensure this no single credible mechanical or electrical control system malfunction can cause a rod cluster to be withdrawn at a speed greater than 72 steps per minute (45 inches per minute).

3.1.3 SAFETY LIMITS

The reactor is capable of meeting the performance objectives throughout core life under both steady state and transient conditions without violating the integrity of the fuel elements. Thus the release of unacceptable amounts of fission products to the coolant is prevented.

The limiting conditions for operation established in the Technical Specification specify the functional capacity of performance levels permitted to assure safe operation of the facility.

Design parameters which are pertinent to safety limits are specified below for the nuclear, control, thermal and hydraulic, and mechanical aspects of the design.

3.1.3.1 Nuclear Limits

At full power (3250 MWt) the nuclear heat flux hot channel factor, $F_q^N = 2.32$, is not exceeded.

For any condition of power level, coolant temperature and pressure which is permitted by the control and protection system during normal operation and anticipated transients the hot channel power distribution is such that the minimum DNB ratio is greater than 1.30* and the linear fuel rating is less than 21.1 kw/ft. For any normal steady state operating condition, the maximum linear fuel rating does not exceed 15.0 kw/ft. This is discussed later in the Section 3.2.2.

---

* 1.30 for LOPAR fuel and analysed to 1.17 for OFA fuel, see Section 3.2.4.3 or for more detail, reference 30.

TABLE OF CONTENTS

d. Pressure switch which automatically starts the common compressor on low penetration air receiver inlet pressure, which is indicative of a unit compressor failure

The discharge from the compressors is filtered and dried before it connects with the instrument air supply to the penetration pressurization system. The filter dryers are provided with a bypass to allow operation of the penetration pressurization air compressors in the event of a filter dryer failure. The air dryers are provided with local indication of pressure and dew-point. A high dew-point alarm is also locally and remotely provided.

The penetration pressurization system for each unit is divided into four zones, with each zone having its own air receiver and its own standby source of nitrogen. Air from the instrument air system or the penetration pressurization air compressors will keep the air receiver in each zone charged to approximately 100 psig. Air receiver inlet pressure is provided in the main control room for each containment. Local pressure indication is provided for each receiver. Low compressor discharge pressure switches actuate the main control room annunciator. If both of these sources of air are lost, then the air receivers themselves will be able to supply air to the penetrations for four (4) hours at the rate of 117 cfh, which is the maximum allowable leakage rate of 0.1% of the containment volume per day, while the air receivers are being drawn down from 100 psig to 50 psig.

The pressurization air to each zone is reduced in pressure to 49 psig after it leaves the air receiver. Each of the four pressurization zones downstream of the reducing stations contains a pressure transmitter and a flow transmitter which provides a signal to pen recorders on the main control board. Bistable alarms actuate the main control room annunciator on high or low pressure or high flow to any zone. Local pressure indication is provided for each zone also.

If the air in the air receivers is reduced in pressure to below 47 psig, then the standby nitrogen system is available to supply nitrogen to the zone whose air receiver is below 47 psig. The standby nitrogen system will provide nitrogen for 24 hours at 47 psig at the rate of 117 cfh which is equivalent to the maximum allowable leakage rate of 0.1% of the containment volume per day. All of these sources of pressure will maintain the weld channels and penetrations at a pressure higher than the post accident design pressure for a time period far in excess of the peak pressure period. Therefore there will be no out leakage of containment atmosphere from the containment.

During normal operation leakage from the pressurized channel and penetration systems will be monitored by measuring and recording the air flow and pressure to each of the four zones in the containment.

The exact location of a leak can be further pinpointed by checking the flows to the various penetrations and weld channels. Each zone is divided into nine or ten stations and approximately ten weld channels or penetrations are supplied from each station. A flow indicator is located in the supply to each station and these can be checked to determine the leakage through each station. By isolating the various weld channel and penetration supply lines coming from each station, an individual leak can be located.

The supply to each zone downstream of the air and the nitrogen pressure regulator is protected by a relief valve set at 53 psig and a rupture disc designed for 60 psig. The penetration pressurization air compressors, the air receivers, the air and nitrogen regulators, the nitrogen bottles, the relief valves and rupture discs, and the flow and pressure recorders are all located outside of the containment. Each of the forty penetration branches contains a local variable-area flow indicator for measuring air flow to the containment. The station flow indicators and the individual isolation valves are located in the containment in an accessible location.

In addition to the weld channels and the penetrations, the following gasketed or valved openings in the containment will be pressurized from this system:

1. The double gasketed space on each hatch of the personnel air lock.

2. The double gasketed space on the interior hatch of the escape hatch.

3. The double gasketed space on the equipment removal hatch flange.

4. The space between the inner and outer pipe of the fuel transfer tube between the blanking flange and the isolation valve.

The electrical penetrations are pressurized from the nitrogen system which backs up the penetration air system. The electrical penetration nitrogen is also backed up by penetration air. The following instrumentation is provided:

a. Local indicating flow switches are provided for each of the four electrical penetration zones. High flow signals initiate the main control room annunciator. Meter bodies meet Class I barrier requirements.
b. Each zone has a high and low pressure alarm switch for initiation of the main control room annunciator.
c. Local pressure indication is provided for each zone.
d. Seismic Class I pressure reducing stations are provided for each zone for regulation of bulk nitrogen, cylinder nitrogen, and back up air.

The penetration pressurization system includes sufficient redundancy and is in compliance with the single failure criteria.

In the event of continuous leakage into the containment from the penetration pressurization system of 0.1% of the containment volume per day, the containment pressure may rise but the pressure and vacuum relief system will be used to keep the containment pressure below the maximum of 0.3 psig.

TABLE OF CONTENTS
(continued)

7.2.2.5.5 High Neutron Flux (Source Range) Trip

The circuit trips the reactor when one of the two source range channels reads above the trip set-point. This trip, which provides protection during reactor start-up, can be manually bypassed when one of two intermediate range channels reads above the P-6 set-point value and is automatically reinstated when both intermediate range channels decrease below this value (P-6) (less than 1% power). This trip is automatically bypassed by two out of four high power range signals (P-10) (approximately 10% power). The trip function can also be reinstated below P-10 by an administrative action requiring coincident manual actuation. The trip point is set between the source range cutoff power level and the maximum source range power level. (See Figure 7.4.1-1.)

7.2.2.5.6 Positive High Neutron Flux Rate (Power Range) Trip

This circuit trips the reactor when an abnormal rate of increase in nuclear power occurs in two out of four power range channels. This trip provides protection against rod ejection accidents of low worth from mid-power and is always active.

7.2.2.5.7 Negative High Neutron Flux Rate (Power Range) Trip

This circuit trips the reactor when an abnormal rate of decrease in nuclear power occurs in two out of four power range channels. This trip provides protection against multiple dropped rods and is always active.

7.2.2.5.8 Overtemperature ΔT Trip

The purpose of this trip is to protect the core against DNB. This trips the reactor on coincidence of two-out-of-the-four signals, with one set of temperature measurements per loop. The setpoint for this reactor trip is continuously calculated (as shown on Figure 7.2.2-8) for each loop by solving the following equation:

$$\Delta T \text{ setpoint} = K_1 - K_2\frac{(1 + \tau_1 S)}{(1 + \tau_2 S)}(T - T') + K_3(P - 2235 \text{ psig}) - f(\Delta q)$$

Where

- K_1 = set point bias (%)
- K_2, K_3 = constants based on the effect of temperature and pressure on the DNB limits, (%/°F, %/psig).
- τ_1, τ_2 = lead-lag time constants (sec^{-1})
- S = Laplace transform variable
- T = average reactor coolant temperature (°F)
- P = pressurizer pressure (psig)
- $f(\Delta q)$ = a function of the flux difference between upper and lower long ion chamber sections (%).
- T' = Loop average temperature $\leq$ 562.2 (°F)

The four long ion chamber units separately feed each overtemperature ΔT trip channel. Thus, a single failure neither defeats the function nor causes a spurious trip. Changes in f (Δq) can only lead to a decrease in trip setpoint.

Initiation of automatic turbine load runback by means of an overtemperature ΔT signal is discussed later in this section.

7.2.2.5.9 Overpower ΔT Trip

The purpose of this trip is to protect against excessive power (fuel rod rating protection). This trips the reactor on coincidence of two out of the four signals, with one set of temperature measurements per loop.

The setpoint for this reactor trip is continuously calculated for each loop by solving equations of the form:

$$\Delta T_{setpoint} = K_4 - K_5 \frac{\tau_3 S}{(1 + \tau_3 S)} T - K_6 (T - T') - f(\Delta q)$$

K_4	= a preset manually adjustable bias (%)
K_5, K_6	= constants relating the effect of T and rate of change of T on overpower limit
τ_3	= rate-lag time constant (sec^{-1})
S	= Laplace transform variable
T	= average reactor coolant temperature (°F)
$f(\Delta q)$	= is a function of flux difference between upper and lower long ion chamber section (%)
T'	= Loop average temperature $\leq$ 562.2 (°F)

Variables in brackets are individually low limited to zero.

Initiation of automatic turbine load runback by means of an overpower ΔT signal is discussed later in this section.

7.2.2.5.10 Low Pressurizer Pressure Trip

The purpose of this trip is to protect against excessive core steam voids and to limit the range of required protection afforded by the overtemperature ΔT trip. This trips the reactor on coincidence of two out of the four low pressurizer pressure signals. This trip is blocked when three of the four power range channels and two of two turbine first stage pressure channels read below approximately 10 percent power (P-7). Each channel is lead-lag compensated.

7.4.3.2 Source Range

The source range output information is tabulated in Table 7.4.3-1. The detector for each source range channel is a proportional counter. The signal received from the counter has a range of 1 to 10^6 pulse per second randomly generated and is received through a low noise discreetly variable gain pulse preamplifier located outside the containment. The preamplifier optimizes the signal-to-noise ratio and also furnishes high voltage coupling to the detector.

The preamp has internal provisions for generating self-test frequencies of 10 counts per second (cps) and 10.24KCPS. These test oscillator circuits are energized by a switch located on the associated source range drawer. The source range channel power supplies furnish low voltage for preamp operation as well as low voltage for the drawer-mounted modules. The preamp is solid state in design with discrete components and includes an impendance matching network between the preamp output and the 75-Ohm triaxial cable.

The preamp output is received at the post-amplifier located on the source range drawer. This module provides amplification and discrimination, both of which are adjustable. Discrimination is provided between neutron flux pulses and combined noise and gamma-generated pulses. The discriminator supplies two outputs: one output, isolated to a scaler-timer unit on the audio-visual channel drawer (see source range auxiliary equipment); and the other to a pulse shaper (transistorized flip-flop circuit) which supplies a constant amplitude pulse to the log integrator module within the source range drawer.

Logarithmic integration of the pulse signal is performed in another modular unit to obtain an analog dc signal. The log is then amplified for local indication on the front panel of the source range drawer, and is also delivered through a parallel run to the source range level bistables and isolation amplifier. The analog output signal is proportional to the count rate being received from the sensor and is displayed by the front panel meter on a scale calibrated logarithmically from 10^1 to 10^6 counts per second. The solid state isolation amplifier provides five analog outputs, all of which are adjustable through attenuator controls. Three outputs are used as follows: as remote indication (0-1 mA); as remote recording (0-50 mV dc); and as an input to the computer (0-5 Vdc). A 0-10 Vdc output is used by the start-up-rate amplifier to produce a start-up rate indication at the main control board. The remaining output (0-5 Vdc) is a spare.

All bistables employ a basic plug-in module with the external wiring determining the mode of operation latching or non-latching and direction of output change with rising power. Bistables have two adjustments: "Trip Level" and "Differential". The first adjustment determines the trip point of the bistable, while the second determines the "dead zone" difference between the trip and release points of the bistable. The bistable module card includes a relay driver circuit made up of an SCR and full-wave bridge configuration. The bistable output controls the SCR gate which, in turn, controls conduction of the full-wave bridge supplying the power to drive up to four 115 Vac relays. All relays are located remote from the Nuclear Instrumentation System (NIS) racks.

The high range reactor trip logic circuitry is developed identical to the low range reactor trip circuitry, but no provision for blocking is included. The high range trip remains active at all times to prevent any continuation of an overpower condition.

The power range rate trip is a circuit that monitors fast rates of change in detector output. It provides protection against multiple rod drops and ejected rod accidents. It is divided into negative and positive rate sections which have setpoints of 5% in 2 sec. The rate trip logic circuitry is developed similar to the low range reactor trip circuitry.

An additional bistable unit monitors the high voltage power supply in the power range. Operation of this unit is identical to that for the source and intermediate ranges. The bistable provides relay actuation in the remote relay racks on failure of power range high voltage. While there is a separate relay for each power range, they control a common "Power Range Loss of Detector Voltage" annunciator on the main control board. Separate local indication of high voltage failure is provided on the power range drawers.

The test-calibrate module which is provided on each power range is capable of injecting test signals at several points in the channel. In all cases, the test signals are superimposed on the normal signal. Test signals can be injected independently or simultaneously at the input of either ammeter-shunt assembly to appear as the individual ion chamber currents. Operation of the test-calibrate switch on any power range will cause the "Channel Test" annunciator to be alarmed on the main control board.

7.4.3.7 Power Range Auxiliary Equipment

7.4.3.7.1 Comparator

The comparator receives an isolated signal from each of the four power range detectors. These signals are conditioned in separate operational amplifier circuits and then compared with one another to determine if a preset amount of deviation of power levels has occurred between any two power ranges. Should such a deviation occur, the comparator output will operate a remote relay to actuate the control board annunciator, "Power Range Channel Deviation". This alarm will alert the operator to either a power unbalance being monitored by the power ranges or to a channel failure. Through other indicators, the operator can then determine the deviating channel(s) and take corrective action. Should correction of the situation not be immediately possible (e.g., a channel failure, rather than reactor condition), provisions are available to eliminate the failed channel from the comparison function. The comparator can then continue to monitor the active channels.

7.4.3.7.2 Remote Recorder

Each power range supplies a 0-50 mVdc signal proportional to 0-120% full power to the selector switches for the two pens on the main nuclear power recorder. The signals from Power Ranges Number 1, Number 2 Number 3, and Number 4 are

The header arrangement at the tank inlet gives the operator freedom to fill, reuse, or discharge gas to the environment simultaneously without restricting operation of the other tanks. During degassing of the reactor coolant prior to a refueling shutdown, it may be desirable to pump the gas purged from the volume control tank into a particular tank and isolate that tank for decay rather than reuse the gas in it. This is done by aligning the control to open the inlet valve to the desired tank and closing the outlet valve to the reuse header. One of the other tanks can be opened to the reuse header at this time if desired, while still another might be discharged to atmosphere.

Before a gas decay tank is discharged to the plant vent for release to atmosphere, a sample is taken to determine the activity concentration of the gas and total activity inventory in the tank. The sample is normally taken by inserting a sample vessel in the gas analyzer vent bypass line, aligning the valves for flow through the vessel, and then manually actuating the gas decay tank "manual select" sample station. The valves are returned to normal alignment and the sample is removed for analysis. Total tank activity inventory is determined from the activity concentration and pressure in the tank.

To release the gas, the appropriate local manual stop valve is opened to the plant vent and the gas discharge modulating valve (RCV-014) is opened at the auxiliary control panel. The plant vent activity level is also indicated on the panel to aid in setting the valve properly. If there should be a high activity level in the vent during release, the modulating valve trips closed. To reopen the valve, the switch must first be reset by returning it to the closed position. The valve can then be repositioned.

As the Chemical and Volume Control system holdup tanks' liquid is processed, gas is returned from the gas decay tanks to the holdup tanks. The gas decay tank supplying the returning cover gas is selected manually at the waste disposal-boron recycle control board by opening the appropriate valve in the return line header.

Control of radioactive gas in the space above liquid surfaces in the liquid radwaste system is achieved by continuous venting of the tanks through a closed system to the filtered vent header. With this type of arrangement the maximum hydrogen concentration is always expected to be well below the lower explosive limit due to the hydrogen limits placed on the reactor coolant system water.

During operation, gas samples are drawn periodically from the Hold Up Tanks as well as from the particular gas decay tank being filled at the time, and automatically analyzed to determine their oxygen content. There should be no significant oxygen content in any of the tanks.

If the daily check of sample results show any tank contains greater than 2% oxygen, steps are taken to isolate the tank and reduce the oxygen content by venting and diluting the tank with nitrogen.

Gas samples from the following 14 points (tanks or common headers) can be drawn:

a. Chemical and Volume Control System holdup tanks
b. Gas decay tanks (2 points)
c. Spent resin storage tank
d. Gas stripper and boric acid evaporator package
e. Volume Control tank
f. Reactor coolant drain tank
g. Pressurizer relief tank

The valves and tubing for the gas analyzer are stainless steel, except for the portion inside the gas decay tank cubicle which is carbon steel. Each sample is analyzed for hydrogen, oxygen and nitrogen concentration by a gas chromatograph using thermal conductivity detectors. The analysis results (% concentration) are printed on a teleprinter. The gas analyzer is able to operate in the following modes: 1) normal automatic scan, 2) automatic scan with selected points omitted, and 3) random manual selection. Most failure modes will cause local annunciation. These failure modes include (but are not limited to) loss of power, loss of various flows, most common sensor failures, etc. The gas analyzer has connections for a chart recorder.

Analysis of individual points may be bypassed if the tank or line is out of service. An analysis sequence takes approximately 5 minutes per point (to account for sample line delay time).

Accuracy of the hydrogen and oxygen analyses are each better than $\pm 1\%$ at the lower explosive limits. Calibration checks are accomplished using pre-mixed gases in cylinders attached to connections provided for that purpose.

No individual grab sample locations are provided in the gaseous waste system although grab samples can be taken at pressure indicator taps. Individual Gas Decay Tanks may be sampled by means of the gas analyzer on the "Manual Select" channel while the "Auto Select" channel monitors the Gas Decay Tank sample header. A grab sample from any individual channel in the gas analyzer may be taken by use of a sample vessel assembly. These portions of the gaseous systems are shown in Figure 11.1-2(1). Surveillance requirements for radioactive gaseous release are stipulated in Technical Specifications Section 4.12.

The Waste Disposal System instrumentation provides for safe, reliable and efficient operation and control of the system. Provisions are made for monitoring any radioactive releases. (Instrumentation in the compressor packages is described in the respective equipment manuals.)

All alarms are located on the waste disposal-boron recycle control panel; all alarms actuated here will actuate a single alarm at the main control panel.

The compressor packages are Nash liquid piston rotory type provided with mechanical seals to minimize leakage of seal water. Construction is of cast iron external and bronze internals with a stainless steel shaft. The compressors are manually or automatically controlled by the gas manifold pressure. While one unit is in operation, the other serves as a standby for unusually high flow or failure of the first unit.

Number	2 (shared)
Location	Auxiliary Building, El.560 feet
System design pressure	150 psig
System design temperature	180°F
Operating design temperature	70-130°F
Suction pressure, N_2 at 140°F	5 psig maximum
Design discharge pressure	110 psig
Design flow (N_2 at 140°F, 2 psig)	40 cfm

11.1.3.14 Gas Analyzer

An automatic gas analyzer is provided which is capable of monitoring the concentrations of oxygen and hydrogen in the cover gas of the Waste Disposal System, Chemical and Volume Control System tanks, boric acid evaporators and gas stripper. Upon indication of a high oxygen level, provisions are made to purge the equipment to the gaseous waste system with an inert gas. A complete discription of the gas analyzer is given in Section 11.1.2.3.

11.1.3.15 Hydraulic Drum Compactor

A hydraulic drum compactor is located adjacent to the decontamination pad at the north end of the 592 foot level in the Auxiliary Building and a box compactor is located on the 617 foot level in the cross town area of the Fuel Building. Compressible wastes are compacted in either machine to reduce their volume. Both are operated locally and exhaust air is vented through HEPA filters.

11.1.3.16 Nitrogen Supply Manifold

A dual stainless steel manifold supplies nitrogen to purge the vapor space of various components to reduce the hydrogen concentration or to replace fluid that has been removed. A pressure controller, which automatically switches from one manifold to the other, assures a continuous supply of gas. Nitrogen is used as a cover gas in the following tanks:

Reactor Coolant Drain Tank
Pressurizer Relief Tank
Volume Control Tank
Spent Resin Storage Tank
Gas Decay Tanks
Holdup Tanks

It is also used to pressurize the accumulators for both units.