UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

September 13, 1993

NRC INFORMATION NOTICE 93-71: FIRE AT CHERNOBYL UNIT 2

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the fact that extensive fires may produce unanticipated challenges such as happened at Unit 2 of the Chernobyl Nuclear Power Station. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On October 11, 1991, Unit 2 of the Chernobyl Nuclear Power Station was operating at 70-percent power. Each Chernobyl unit has two twin, independent turbogenerators and all four units share a common turbine hall (see Attachment 1). In order to perform minor repairs and adjustments on turbogenerator 4 (TG-4), operators reduced Unit 2 reactor power and isolated the steam supply to TG-4. At 7:46 p.m., the operators switched off the generator excitation field and opened disconnect breakers 1, 2, and 3 in the 330 kV switchyard to electrically isolate TG-4.

At 8:10 p.m., TG-4 had coasted down to about 150 rpm when disconnect breaker 2 spuriously closed and reconnected TG-4 to the electrical grid. The generator rotor motorized on the reverse-power condition and accelerated to synchronous speed (3000 rpm) in under 30 seconds. The influx of current to TG-4 overheated the conductor elements and caused a rapid degradation of the mechanical end joints of the rotor and excitation windings. A centrifugal imbalance developed and damaged generator bearings 10 through 14 and the seal oil system allowing hydrogen gas and seal oil to leak from the generator enclosure. Electrical arcing and frictional heat ignited the leaking hydrogen and seal oil creating hydrogen flames 8 meters [27 feet] high and dense smoke which obstructed the visibility of plant personnel.

When the burning oil reached the busbar of the generator it caused a three-phase 120,000 amp short circuit. Within 0.07 seconds, the generator fault protective circuits sensed the short and opened disconnect breaker 2,

which spuriously closed again 0.25 seconds later. The protection system reopened the breaker 0.2 seconds after the closure and again the breaker spuriously closed. Finally, protection circuits in the 330 kV electrical grid disconnected the generator 0.27 seconds after the closure by opening a remote breaker located in the town of Korosten, about 120 kilometers [72 miles] away. Unit 2 control room operators shut down the reactor and initiated the maximum allowable cooldown rate to achieve a safe reactor configuration.

Fire fighting efforts focused on containing the fire and preventing it from spreading to adjacent equipment. There was little concern for the turbine hall roof catching fire because the asphalt coating on the roof had been removed after the 1986 accident at Chernobyl Unit 4. However, the local ventilation systems, which were the only method available for heat and smoke removal, were unable to cope with the smoke and heat generated by the fire. The fire brigade was concerned for the structural integrity of the roof because the roof supports had no heat retardant coating and because sprinkler systems in the turbine hall were not designed to cool the structural supports. The fire brigade attempted to cool the supports by spraying them with water from below but were unsuccessful because the plant fire pumps could not provide adequate flow to the area sprinkler systems and the local fire-fighting efforts at the same time. The metal trusses of the roof structure reached a temperature greater than 900°C [1650°F] and collapsed at 8:35 p.m.

A 50 meter by 50 meter [165 feet by 165 feet] section of the roof collapsed onto the turbine deck and also onto an adjacent pit that contained the main feedwater pumps, the auxiliary feedwater pumps and their associated control cabinets. Damage to the pump systems and a fire in one control cabinet disrupted makeup water flow to the reactor cooling system. The operators cut the electrical power to the pump motors and the control cabinets to remove them as a potential ignition source. Because of the significant amount of damage, the operators believed that the main feedwater and auxiliary feedwater pumps could not be readily restored. Therefore, the operators added water to the reactor primary coolant circuit by opening the steam relief valves to reduce pressure and aligning a low-pressure nonsafety-grade condensate pump to the auxiliary feedwater system piping. This arrangement made controlling the steam separator drum water levels difficult but allowed the operators to provide core cooling throughout the event. The fire was extinguished by 11:30 p.m.

Discussion

An investigation of the event later determined that a short circuit in the control wiring for generator disconnect breaker 2 caused the repeated failures of the breaker to remain open. This condition was critical because there was no redundant on-site isolation breaker for the generator output such as is included in the more recent design of Chernobyl Unit 3.

A notable safety significant aspect of the Chernobyl fire was the complete loss of the main feedwater and auxiliary feedwater systems. Because redundant safety components were not truly independent (i.e., there were no separate and protected cubicles for the auxiliary feedwater pumps), a single structural component failure led to the common failure of all feedwater pumps. The proposed corrective actions include: (1) installation of three additional emergency feed pumps outside of the turbine hall, (2) installation of an automatic sprinkler system for the metal structure of the turbine hall and roof, and (3) a review of the design of the smoke removal system in the turbine hall and installation of a more effective system.

This event illustrates that extensive fires may place unanticipated loads on fire protection systems and that structural failures could cause failures of multiple trains of safety-related systems and challenge the true separation, independence, and redundancy of safety-related components.

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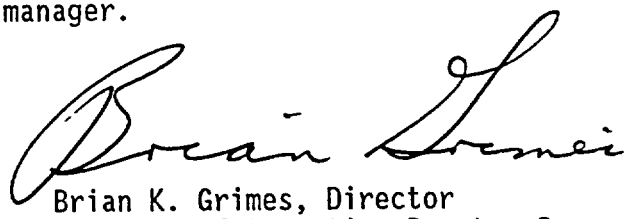
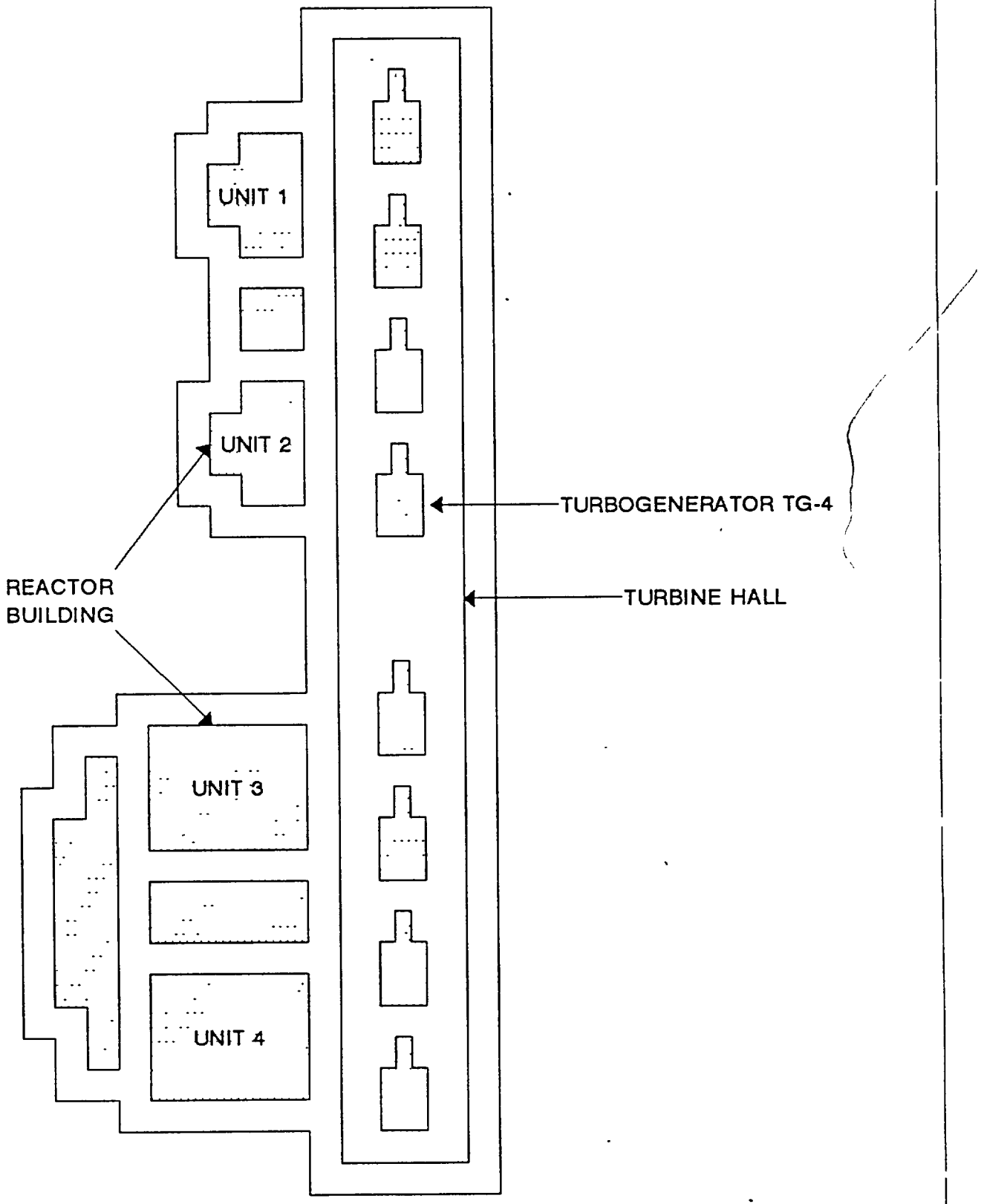


Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contact: Eric J. Benner, NRR
(301) 504-1171

Attachments:
1. Chernobyl Turbine Hall Layout
2. List of Recently Issued NRC Information Notices

CHERNOBYL TURBINE HALL LAYOUT



LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-70	Degradation of Boraflex Neutron Absorber Coupons	09/10/93	All holders of OLs or CPs for nuclear power reactors.
93-69	Radiography Events at Operating Power Reactors	09/02/93	All holders of OLs or CPs for nuclear power reactors and all radiography licensees.
93-68	Failure of Pump Shaft Coupling Caused by Temper Embrittlement during Manufacture	09/01/93	All holders of OLs or CPs for nuclear power reactors.
92-16, Supp. 2	Loss of Flow from the Residual Heat Removal Pump during Refueling Cavity Draindown	08/23/93	All holders of OLs or CPs for nuclear power reactors.
93-67	Bursting of High Pressure Coolant Injection Steam Line Rupture Discs Injures Plant Personnel	08/16/93	All holders of OLs or CPs for nuclear power reactors.
93-66	Switchover to Hot-Leg Injection Following A Loss-of-Coolant Accident in Pressurized Water Reactors	08/16/93	All holders of OLs or CPs for pressurized water reactors.
93-65	Reactor Trips Caused by Breaker Testing with Fault Protection Bypassed	08/13/93	All holders of OLs or CPs for nuclear power reactors.
93-64	Periodic Testing and Preventive Maintenance of Molded Case Circuit Breakers	08/12/93	All holders of OLs or CPs for nuclear power reactors.
93-63	Improper Use of Soluble Weld Purge Dam Material	08/11/93	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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orig /s/'d by BKGrimes

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* See previous concurrences

OFC	OEAB:DORS	SC/OEAB:DORS	PUB:ADM	SPLB:DSSA
NAME	EBenner*	EGoodwin*	Tech Ed*	CM for West*
DATE	05/13/93	05/19/93	05/13/93	08/25/93

OFC	C/SPLB:DSSA	CEP:OIP	C/OEAB:DORS	OGCB:DORS
NAME	CMcCracken*	JERamsey*	AChaffee*	JBirmingham*
DATE	08/25/93	08/26/93	08/27/93	09/02/93

OFC	C/OGCB:DORS	D/DORS
NAME	GMarcus*	BGrimes
DATE	09/02/93	09/8/93

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Per discussions with NRR, all information in this IN is already publicly available.
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