

EFFECTS OF APRIL 17, 1978 TORNADO  
ON CATEGORY I STRUCTURES AT THE  
GRAND GULF NUCLEAR STATION

PREPARED BY  
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JULY, 1978

## CONTENTS

- 1.0 Introduction
- 2.0 Effects on Category I Structures
- 3.0 Listing of Tornado Related Nonconformance Reports for Category I Structures, Systems and Components
- 4.0 Photographs

## 1.0 INTRODUCTION

On the evening of April 17, 1978 a tornado touched down at the construction site of the Grand Gulf Nuclear Station causing damage to both permanent and temporary structures, heavy construction equipment and stored materials.

A layout of the construction site showing the approximate path of the tornado and the damaged structures is shown on the attached Bechtel drawings SKC-0008T and SKC-0012T.

Observations made at the construction site indicated the damage to the permanent structures was due to the impact of collapsing cranes or other falling construction equipment. A detailed description of damage to each Category I structure is contained in Section 2.0 of this report.

Reference is made to two reports which also describe this tornado and the resulting damage:

- 1) McDonald, J. R., 1978: "Assessment of Tornado Damage to the Grand Gulf Nuclear Generating Station," Institute for Disaster Research, Texas Tech University, Lubbock, Texas.
- 2) Fujita, T. T., 1978: "Aerial Survey of Grand Gulf Plant and Vicinity after the April 17, 1978 Tornado," SMRP Research Report No. 162, University of Chicago, Chicago, Illinois.

The observations and conclusions in this report were made independently of those referenced above.

Section 3.0 of this report is a listing of Nonconformance Reports (NCR) which were written to document and repair the tornado damage to Category I structures, systems, and components.

Based on the structural evaluation of the wind damage to several miscellaneous structures (warehouse siding and light standards) the maximum wind speed has been estimated to be between 120 mph and 130 mph.

This agrees with the assessments contained in the reports of J. R. McDonald and T. T. Fujita referenced above.

## 2.0 EFFECTS ON CATEGORY I STRUCTURES

### 2.1 CONTAINMENT

Tornado winds caused the collapse of the south tower construction crane which damaged the freestanding Unit 1 containment liner plate hip course (see drawing SKC-0012T and Photograph 4-1). Most of the damage extended between azimuth  $53^{\circ}$  and azimuth  $153^{\circ}$  above elevation  $247' - 6''$  (see Photograph 4-2) and between azimuth  $213^{\circ}$  and azimuth  $273^{\circ}$  above elevation  $247' - 6''$ .

There was less severe damage between azimuth 173° and azimuth 213° above elevation 268' - 0". This consisted of buckling of the liner plate due to the impact. The portions of liner plate that were damaged were being erected at the time of the tornado and had not been accepted as part of the permanent plant. The fabricator of the liner plate has removed the damaged portions and replaced with new material.

An inspection of the permanent structure revealed no major damage to its structural integrity. No separation occurred between the liner plate and the cast concrete. Minor chipping of concrete cover occurred in several areas and a few exposed reinforcing bars were bent but there was no general cracking.

The chipped concrete was repaired using the applicable concrete specification. Bent reinforcing bars were heat bent back into position and examined using nondestructive tests.

Some floor grating was dented when a construction welding machine was blown from a scaffold. The sections of grating affected were replaced.

No damage to the Unit 2 containment structure was detected.

## 2.2 AUXILIARY BUILDING

When the south tower construction crane collapsed over the Unit 1 auxiliary building the counterweight and motor fell onto the roof slab at El. 228'-0". The weight of the motor and counterweight was estimated to be 12 tons.

At the time, there were steel frames, concrete forms, pipe shoring and scaffolding, loose timbers, and other stacked construction materials placed at various locations on the slab. These items partially absorbed the impact of the counterweight and motor with the result that only superficial damage was sustained by the composite roof slab.

A field survey of structural connections and slab deflections indicated that there was no damage to the bolts or welds and no permanent deflection of the slab under the impact area. From this it has been concluded that the loading to the structure was within the elastic range of the steel and concrete. In the impact area there is a margin of additional shear capacity in the structural connections of between 14 and 59 kips. Neither visual cracks on the top of the concrete slab nor deflection of the steel decking underneath was observed.

This leads to a conclusion that the impact was insufficient to impair the integrity of the structure.

No damage to the Unit 2 auxiliary building was detected.

## 2.3 CONTROL BUILDING

No visible damage to this structure was detected except some debris accumulation in front of the main entrance.

## 2.4 DIESEL GENERATOR BUILDING

No visible damage to this structure was detected.

2.5 OTHER CATEGORY I STRUCTURES

No damage to the standby service water cooling towers and basins, the seismic Category I manholes or the seismic Category I electrical ductbanks was detected.

3.0 LISTING OF TORNADO RELATED NONCONFORMANCE REPORTS FOR CATEGORY I STRUCTURES, SYSTEMS AND COMPONENTS

3.1 CONTAINMENT

3.1.1 NCR T-2561, NCR T-2564, and NCR T-2565

Damage: Sections of cooling spray pipe mounted on the containment hip course liner plate were damaged when they fell from their supports.

Disposition: Damaged pipe will be scrapped and replaced.

3.1.2 NCR T-2563

Damage: A section of pipe in the fuel pool cooling and clean-up system which was partially embedded in concrete was dented when hit by flying debris.

Disposition: After radiographic examination of the pipe it was determined that the pipe was not structurally impaired. The pipe will be used as is since the dent will not significantly affect the system flow characteristics.

3.1.3 NCR T-2562

Damage: A section of pipe in the RHR system was dented when hit by flying debris.

Disposition: A detailed examination of the pipe including ultrasonic testing and surface examination was performed on the pipe. It was found that the structural integrity of the pipe was not impaired and therefore will be used as is.

3.2 AUXILIARY BUILDING

3.2.1 NCR T-2573

Damage: Twenty #4 concrete reinforcing "U" bars for the enclosure building curb were damaged by the tower crane.

Disposition: The damaged bars were cut off at the concrete surface. New bars were grouted in place using applicable specifications.

3.2.2 NCR T-2574

Damage: Two #5 concrete reinforcing "U" bars for the roof parapet wall were bent. At the same location a 2.5 square foot area of concrete was chipped to a depth of 6 inches.

Disposition: The damaged bars were cut off at the concrete surface. New bars were grouted in place and the concrete was repaired using applicable specifications.

3.2.3 NCR T-2575

Damage: The top surface of a concrete wall was chipped in four places due to the collapse of the south tower crane. Embedded reinforcing steel was exposed and several #14 reinforcing bars were bent.

Disposition: Reinforcing bars were heat bent into the proper position and examined by nondestructive tests. The concrete was repaired using applicable specifications.

3.2.4 NCR T-2547

Damage: The pinion gear and pinion cover of the spent fuel cask crane trolley was damaged.

Disposition: The gear and cover will be scrapped and replaced.

3.2.5 NCR T-2556

Damage: A trambeam support for the spent fuel cask crane was struck by falling debris.

Disposition: After an inspection of the member and the connection welds it was found that the member was not structurally impaired. The support will be repainted to the manufacturers specifications.

3.3 CONTROL BUILDING

No NCR's were written in relation to this structure.

3.4 DIESEL GENERATOR BUILDING

No NCR's were written in relation to this structure.

3.5 OTHER RELATED EFFECTS

3.5.1 NCR T-2594

Damage: Ceramic tile for the standby service water cooling tower which was being stored in the plant yard was damaged by wind forces.

Disposition: Broken tiles will be scrapped and replaced.

3.5.2 NCR T-2570

Damage: Tornado winds damaged the environmental control equipment of the concrete testing facility for the moist curing rooms.

Disposition: An alternative method of curing the concrete samples (wet burlap) was approved on an interim basis while repairs were made to the equipment.

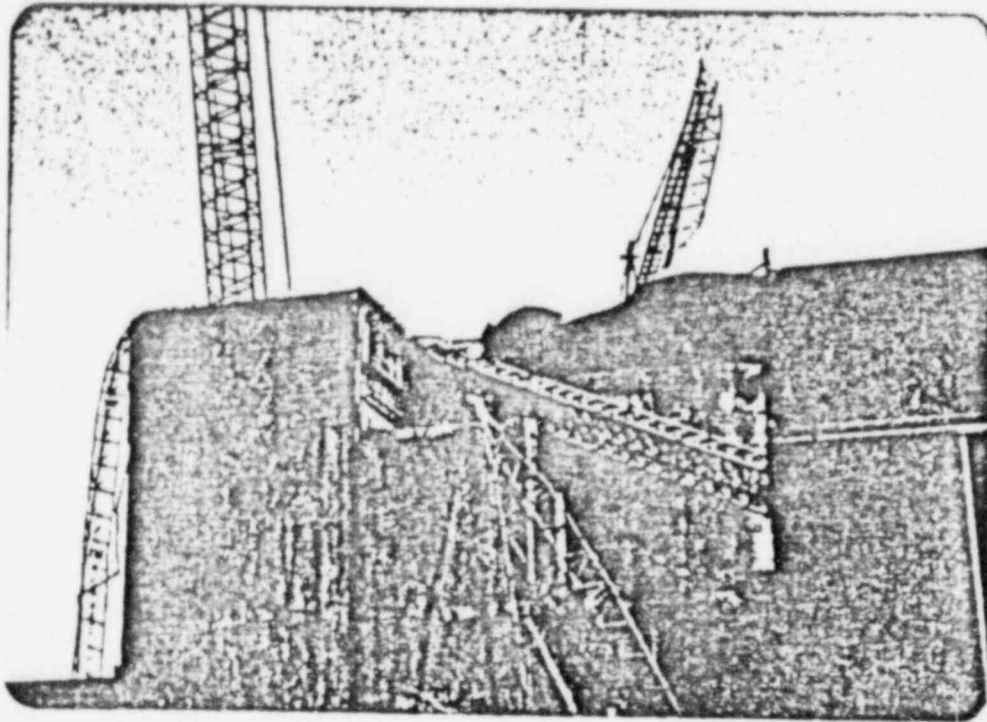
3.5.3 NCR T-2571

Damage: Some test data which was to be included in the testing documentation for concrete produced on April 14 and 17, 1978 was lost due to the tornado.

Disposition: The concrete produced was considered acceptable and used as is. The remaining documentation available indicated that the concrete was of acceptable quality. In addition, the results of the 28 day compressive strength tests met all of the requirements of the applicable specifications.

#### 4.0 PHOTOGRAPHS

- 4.1 South elevation of the Unit 1 containment and auxiliary building showing the collapsed south tower crane across the auxiliary building roof slabs at El. 228'-0" and El. 266'-0" (not poured) with boom draped over the west (left) side.





4.2 Damage to the freestanding Unit 1 containment liner plate between azimuth  $53^{\circ}$  and  $153^{\circ}$ . Concrete shown is poured to El. 243'-6".

