



# Engineering Ethics: Case Study of the TV Antenna Tower Collapse

An Online Continuing Education Course for Engineers

**Course Number: ET-1002**

**Credit: 1 Hour / 1 PDH / 1 CPD**

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*The following case is based on an actual incident. However, individual actors and company names have been changed due to possible pending litigation. In addition, although conversations and memorandums used are based on evidence surrounding the case, they are hypothetical in nature, and are used to illustrate important issues rather than to attempt an actual reenactment of what “really” happened.*

## INTRODUCTION TO THE CASE

On December 7, 1982, a television station video crew was filming the raising of their new television tower in Missouri City, Texas. The antenna was designed and manufactured by Antenna Engineering, Inc., a moderately-sized local firm. Riggers, Inc., a small local firm, was contracted to raise and assemble the antenna. During the initial design, Antenna Engineering submitted antenna plans to Riggers for their approval. Riggers approved the plans which provided for placement of the antenna hoisting lugs. These lugs provided attachment points for lifting cables which would be used for removing the antenna sections from the delivery truck, and for hoisting the antenna into the air for final assembly on a 1000 foot tower.

A crew of riggers who had constructed such towers for many years was on-site. The crew used a vertically-climbing crane mounted on the already constructed portion of the tower to lift each new section of the tower, and finally, the two-section antenna onto the top of the tower. The design called for a three-legged tower, and as each new section was lifted, it was positioned and bolted onto the previous tower sections, one piece at a time. The tower legs were solid steel bars with 8 inch diameters. The tower sections weighed approximately 10,000 pounds and were each 40 feet long. They were raised without incident to a height of about 1000 feet.

The two final antenna sections arrived at the site and assembly proceeded as planned, until the last antenna section was ready to be hoisted into position. This section was different from the other sections of the antenna because it had microwave baskets attached to the sides of the antenna. The placement of the hoisting lugs allowed the antenna to be lifted horizontally off of the delivery truck, but the baskets interfered with the lifting cables when the antenna was rotated

to a vertical position. A make-shift extension to the lifting lug had to be fashioned by the riggers to permit the last section's vertical hoisting. Unfortunately, on the day of videotaping, something went wrong during the hoisting of this last section, and while the antenna was being hoisted, the bolts on the make-shift lifting lug extension failed.

The result was a tragedy. Several riggers fell 1000 feet to their death. The video camera caught this catastrophe on film, and through its footage, investigators were able to discover where the failure initiated, and why the accident occurred. It was determined that insufficient sized bolts on the make-shift lifting lug extension failed. The falling debris severed one of the tower's guy wires, causing the tower to collapse.

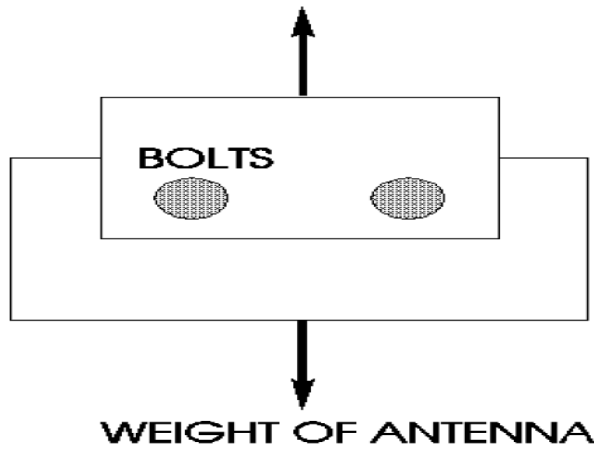
The case of the antenna tower collapse raises serious questions about the design engineer's social responsibility to ensure safety on the construction site, and poses additional questions about product liability issues in engineering and ethics.

Ethical issues raised by the case involve social responsibility versus legal liability, engineering responsibility for failed innovation, problems associated with design implementation, and liability and negligence issues. While valuable for all engineering students, the case is particularly well suited for statics, construction engineering, and structures courses.

## **THE PROBLEM**

Riggers, Inc. could not hoist the last antenna section using the lifting lugs Antenna Engineering provided due to interference with microwave baskets. Antenna Engineering refused permission for Riggers to remove the basket and reassemble after hoisting.

**Figure 1: Model Riggers Thought Was Correct**



$$\text{STRESS} = \text{WEIGHT} / 2 * \text{BOLT AREA}$$

Calculation of stress in bolts = Total Antenna Weight / (2 \* Total Bolt Cross-sectional Area)

**Figure 2: Model Riggers Should Have Used: Free Body Diagram of Lifting Bar and Analysis of Riggers' Solution**



Assuming that the angle that the tower hangs is relatively small, which it was, and that the bolts were about 1 foot apart, and that the supporting channel was about 6 feet long, the load in the bolts is actually a combination of direct shear, plus the load due to the moment caused by the length of the channel. Thus:

Sum of Moments about the bolt on the left end of the channel =

0 = Weight of antenna \* 6 feet - Added force in bolt \* 1 foot, such that

Additional force in bolt = 6\*weight of antenna, which when added to the direct force of 1 \* Weight of Antenna gives a total load on the right hand antenna bolt of 7\*Antenna Weight.

The corresponding shear stress on each bolt is thus: Stress = (7\*Antenna Weight)/Area of bolt

Or, in other words, the stress (for these assumed numbers) in the bolts is seven times what Riggers thought it would be.

## INDIVIDUALS INVOLVED IN THE TV ANTENNA TOWER COLLAPSE CASE

**Antenna Engineering, Inc.**—designed and built the antenna.

**William (Bill) Harris**—President. Harris recommended to Jordan that Antenna Engineering, Inc. not get involved with Riggers' problems regarding lifting the antenna tower, because they might incur liability.

**Harry Jordan**—Head of Engineering Division. Jordan told Riggers that they would not authorize removing the microwave baskets, yet he also told Riggers that the engineering firm was no longer responsible, once Riggers accepted their design plans.

**Riggers, Inc.**—contracted to assemble the antenna.

**Frank Catch**—President.

**Randall Porter**—Vice President. Made the initial call to Antenna Engineering, Inc., detailing the problems Riggers was having lifting the top antenna section with the microwave baskets on it.

**Bob Peters**—Lead Lift. One of the workers killed in the collapse.

**Kevin Chapp**—Cable Operator. Talked to Peters before the catastrophe, asking about the safety of the operation.

## ANALYSIS OF THE FAULTY DESIGN

In 1982, an antenna was designed and manufactured by Antenna Engineering, Inc. (a moderately-sized local firm). Riggers, Inc. (a small local firm) was contracted to raise and assemble the antenna. During the initial design, Antenna Engineering submitted plans to Riggers for their approval. Riggers approved the plans which provided for placement of the hoisting lugs. These lugs provided an attachment point for lifting cables which would be used for removing the antenna sections from the delivery truck, and for hoisting the sections into the air for assembly.

On November 18, 1982, Riggers called Antenna Engineering and asked if it was acceptable to remove the microwave baskets on the top 100 foot section of the tower so they could lift the antenna into position, and then reinstall the baskets in place. Antenna Engineering told Riggers that it was not acceptable. At a previous job

Antenna Engineering had installed similar baskets, but they were not installed properly. This time, they were not reinstalling properly, which cost them a great deal of money. The problem, which cost them a great deal of money, was that the lifting ears in the microwave baskets were not in the right position. The problem took place between Randall Porter and Harry Jordan, the engineering division manager at Antenna Engineering's

*Porter:* Harry, this is a problem on Tower 17.

*Jordan:* How so?

*Porter:* Well, thus far we've had problems with the lifting ears in such a position that they're not getting into the microwave baskets.

*Jordan:* Well, we put the baskets in the right place. The right between two baskets, weren't they?

*Porter:* Yes, and that was the problem. It was on top of the previous antenna. The crane is barely able to get the antenna up high enough to get it to the preceding section as it is. No way can we lift it to the top horizontally.

*Jordan:* Well, what do you suggest? We pretty well signed off when you accepted the plans, and don't have any connection with the construction of the antenna. We leave getting it up in the air pretty much to you guys. Not that we don't want to help in any way we can, but you and your people put these towers up every day of the year, and we really don't want to start getting into that area.

*Porter:* No, I understand that, but it's just that we really don't have an engineer on our staff who can redesign those little ears and put them in a location that will work. So what we

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