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Dam Safety is No Accident

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Dramatic television coverage of the devastation caused by recent dam failures does not encourage a good night's sleep. For those Texans living along a river or in a flood plain, the news probably assures a fitful night of WHAT IF.

WHAT IF the large dam upstream settles unevenly.

WHAT IF the engineers building the new dam have miscalculated its strength.

WHAT IF the old dam to the north weakens because of water seepage.

WHAT IF the rains continue to overflow small dams, and that water is too much for larger dams, and . . .

Perhaps a review of the work underway by safety experts in the state will dispel some of these nightmarish possibilities.

Dam Safety Unit

The Texas Department of Water Resources (TDWR) has the responsibility for safe construction and maintenance of all nonfederal dams in Texas. Field level responsibility for implementation rests with the Dam Safety Unit headed by John Clarke. His team of eleven engineers and technicians maintains a current inventory of dams in Texas and ensures that they are designed, constructed, and maintained as safely as possible. The Dam Safety Unit is responsible for:

- Review and approval of construction plans and specifications of proposed dams to assure safety in design.
- Inspection during the construction phase of each project to assure compliance with the approved plans and specifications.

- Inspection of existing dams to assure that they do not become hazards due to neglect or damage.

Anyone wishing to impound more than 200 acre-feet of water must have plans approved by the TDWR Dam Safety Unit. Clarke says there is an almost endless list of individuals and agencies who build and maintain dams in Texas. The list includes ranchers, farmers, municipalities, power companies, land developers, river authorities, federal agencies, water districts, and numerous types of industries.

The Dam Safety Unit staff requires that the owner of a proposed dam hire a consulting engineer to complete all tests and design. Clarke's staff looks at the plans to see that the dam is designed in accordance with good engineering practices so that it will not overturn, slide, or settle to an undesirable extent, or that excessive seepage will not occur under or through the dam. It is their responsibility to see that proper safeguards are planned to assure the dam's safety.

During the time that a dam is under construction, Clarke requires a monthly report from the construction firm telling of activities which have taken place that month. His staff also conducts on-site inspections at least once a month during the construction period to verify that it is being constructed in accordance with plans and specifications.

Periodic Inspections

A follow-up inspection is conducted six months after construction has been completed, then once every two years. Inspectors look for any movement in the dam and any kind of seepage. Growth on the dam (large trees or plants) can weaken the dam, so plant control on a dam is important.

Although a dam looks motionless, internal stresses develop throughout its life as it settles and shifts under the enormous weight of the water and the structure itself. To detect potentially dangerous changes, every big dam should have an array of instruments such as strain gauges and pressure measuring devices buried inside the dam.

According to Clarke, inspections conducted by his staff of engineers are not "abbreviated, cursory, through the windshield affairs." They result in a comprehensive report of all aspects of the structure with recommendations for improvement. The results of each inspection are evaluated and structural design adequacy studies performed as necessary. Where the need for corrective action is indicated to eliminate a public hazard or to protect structures, owners are advised of existing or potentially-hazardous structural conditions and furnished technical advice on recommended corrective measures.

These recommendations may be as simple as suggesting removal of brush and trees on a dam or may require a consulting engineer make detailed evaluations of the safety of the structure. Failure to comply with TDWR recommendations can result in a fine of up to $1,000 per day. The eleven men in Clarke's unit inspect all dams in Texas except Corp of Engineers dams.

Corps of Engineers

The 24 dams in Texas built and maintained by the U.S. Army Corps of Engineers are inspected daily by a resident engineer. They are also inspected periodically by a team of safety experts from district, division, and national Corps offices. These safety experts include foundations and materials specialists, soil scientists, and hydraulic and structural engineers.

Although large dams in Texas have been regularly inspected since 1969, not all states have been as careful. A study conducted by the United States Committee on Large Dams suggests that most states have not been alert to the dangers presented by dams in their territory. The study revealed that five states required no license or permit before a dam could be constructed and thirteen states had no printed regulations on the subject of dam building. Seventeen states reported that they had no authority over the way dams were operated; ten states had no regulations saying that dams must be supervised by a professional engineer.

The committee concluded that dam failures have resulted from ignorance, poor workmanship, and lack of attention to details either in design, in construction, or in maintenance. There is always a danger that some item has been overlooked whether it be in the assessment of the design, interpretation of foundation conditions, or in the assumed loadings imposed upon the dam.

National Safety

In a move for uniformity throughout the U.S., and as a result of several dam failures across the nation, the Federal Dam Inspection Act (PL 92-367) was passed by Congress in 1972. This authorized the U.S. Army Corps of Engineers to initiate a program for safety inspections of dams throughout the United States.

Some important features of this legislation include classification of dams with respect to their size and the total risk to the community and the requirement that field inspections be conducted by qualified engineers and other knowledgeable specialists. Similarly, technical investigations must be made under the direction of profes signal engineers experienced in design and construction of dams.

The act provided for an inventory of all dams in the United States over 25 feet in height or impounding more than 50 acre-feet of water. This inventory, reported to Congress by the Corps of Engineers in 1974, revealed about 49,300 such dams in the country.

The inventory in Texas was conducted by the Water Rights Commission (now part of the Texas Department of Water Resources) through a contract agreement with the Corps of Engineers. Of the 4,237 dams inventoried in Texas, 524 were classified as having a high hazard potential. This classification means that if a failure occurred, it would cause "more than a few deaths" and also cause "excessive economic loss."

Dams classified as high hazard potentials are to be inspected regularly according to specifications of the Federal Dam Safety Act. The Corps of Engineers has contracted with the TDWR to have that state agency conduct inspections in Texas. "The dams under this program," according to Clarke, "have previously been inspected by our staff on a regular basis as part of our state dam safety program. It is anticipated that only minor modifications of our current procedures will be necessary to comply with federal guidelines."

Embankment Dams

The basic type of dam in Texas is an embankment dam--a sloping mound of dirt, gravel, or rocks. It gains its stability from its own weight thus it is also called a "gravity dam." The International Commission on Large Dams defines an embankment dam as "any dam constructed of excavated materials placed without addition of binding materials other than those inherent in the natural material. The materials are usually obtained at or near the dam site."

The most important requirement for embankment dams is that materials be selected and compacted so that settlement in various directions will not fracture the core, or impervious zone. All dams must contain an impervious zone to make them watertight; however, a large part of an embankment dam is not watertight.

Two types of embankment dams in Texas are earth fill and rockfill. An earthfill dam is constructed primarily of compacted earth. A rockfill dam is dependent for its stability primarily on rock and dependent for water tightness on compacted or hydraulically placed earth from an impervious upstream blanket or center core.

Each dam is unique; its watertightness and stability directly related to the materials used for its construction and the materials upon which it is founded. The type and proportions of a dam for a particular site will depend primarily upon the foundations and the materials available for its construction.

According to Clarke, methods of soil compaction have greatly improved dams in the past 40 years. In addition, procedures for controlling the compaction and tests which verify how well the soil is compacted have increased the accuracy in building embankment dams.

Clarke states that erosion is one of the biggest problems with embankment dams. Both faces of a dam must be protected against structural damage. In normal circumstances the downstream face will only be subjected to the forces of nature such as rainfall and wind, but the upstream face must be protected against erosion or disturbance by wave action, ice, or floating debris. Various methods of protection include large rocks (rip-rap), precast concrete forms, soil cement, or waterproofing membrane. Protection must extend well above and below the operating range of the reservoir. Reinforced concrete is also used around an embankment dam's spillway and flood gates.

Future Safety

What will happen as large Texas dams--all now under 75 years of age--grow older?

- Maintenance and surveillance will become increasingly important.
- Reservoirs will hold much less water because of natural siltation and accumulation of organic matter. (This could mean much more chance of "overtopping" the dam--water flooding over the top of the dam.)
- Development on watershed will change flood rates and volumes of runoff into reservoirs.
- Movement of soil underneath and within dam structure will place ever-increasing stress on present dams.

Destruction of an unsafe dam generally has many political and economic ramifications. A dam's destruction means siltation and debris into downstream channels, less flood protection for residents downstream, and major decrease in property values around the reservoir.

The United States has experienced more than 50 major dam failures in the past 25 years. None, however, have been in Texas. Certainly the safety vigil at the state and national levels will continue and probably intensify.

Can Texans afford to sleep well at night? Yes. Except WHAT IF. .