
HYDRAULIC STEEL STRUCTURE (hss)
Inspection program
June 2007

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HSS and Dam Safety

What is HSS?

What are our responsibilities?

What is the COE policy?

Why is HSS so important?

What are the challenges?

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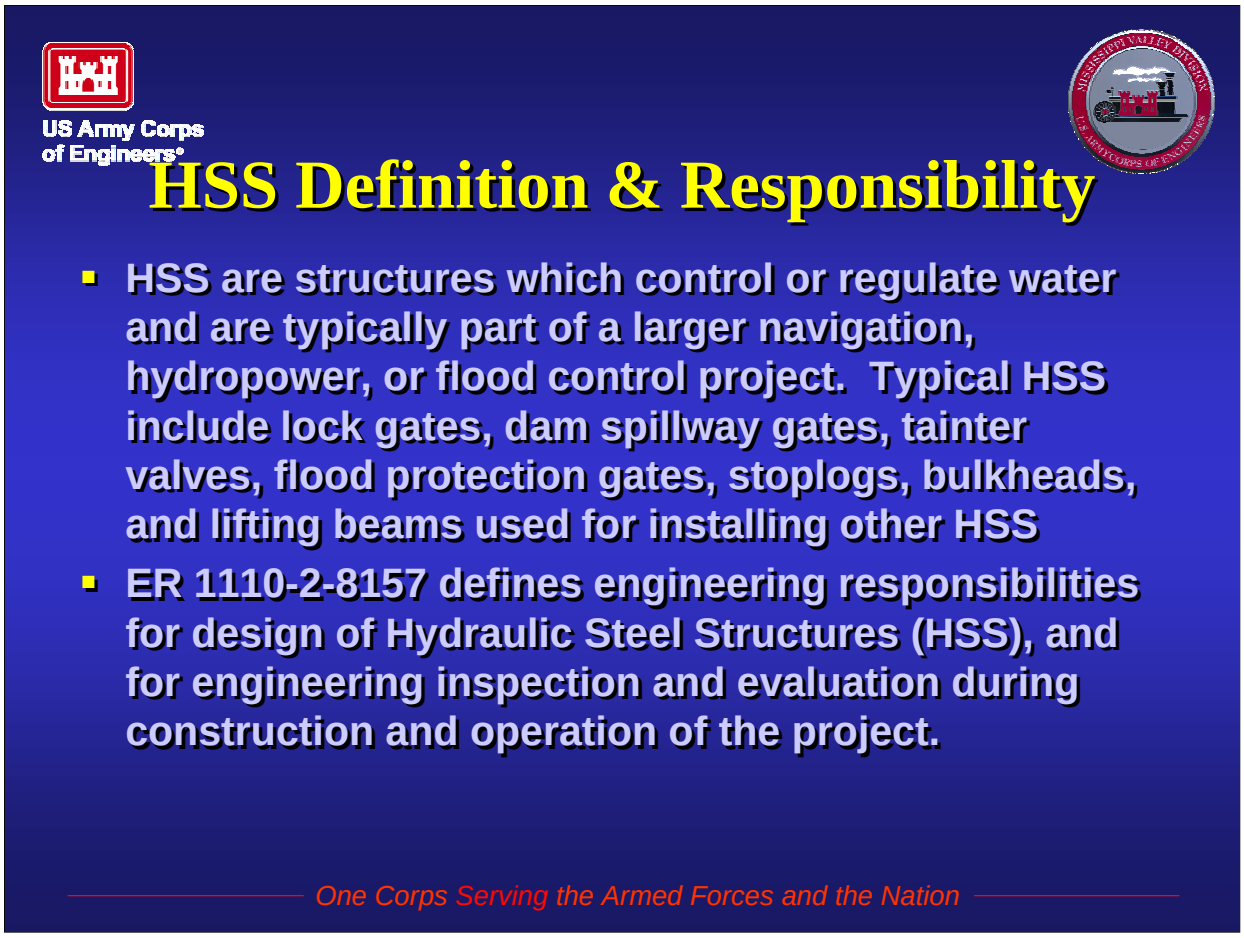


ESSENTIALLY ALL OF OUR STEEL GATES & BULKHEADS ARE HSS UNLESS THEY ARE LOW HD MANUF. GATES..

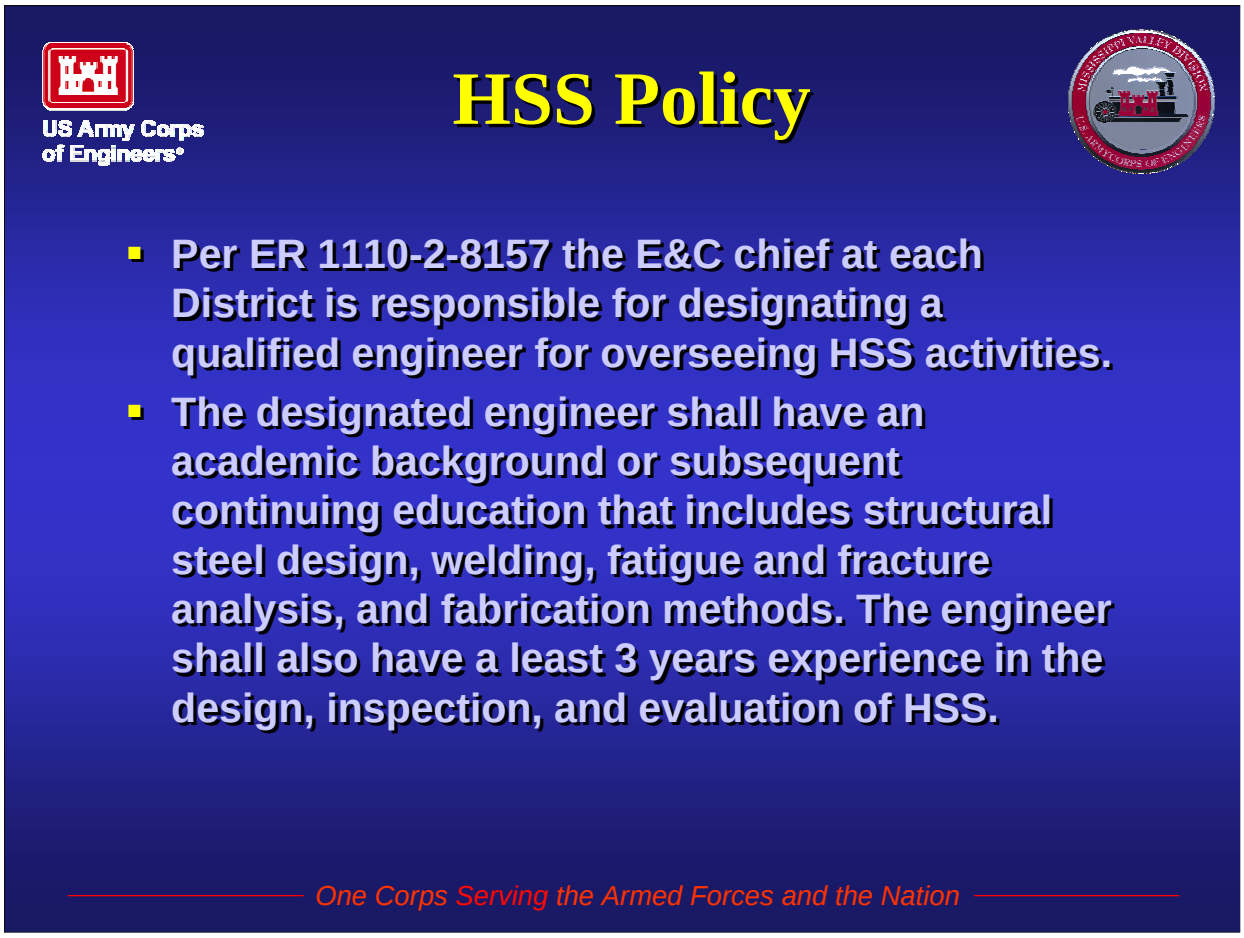
WE HAVE A ENGR REGULATION THAT DEFINES THE ENGR RSPONSIBILITIES FOR

1. DESIGN

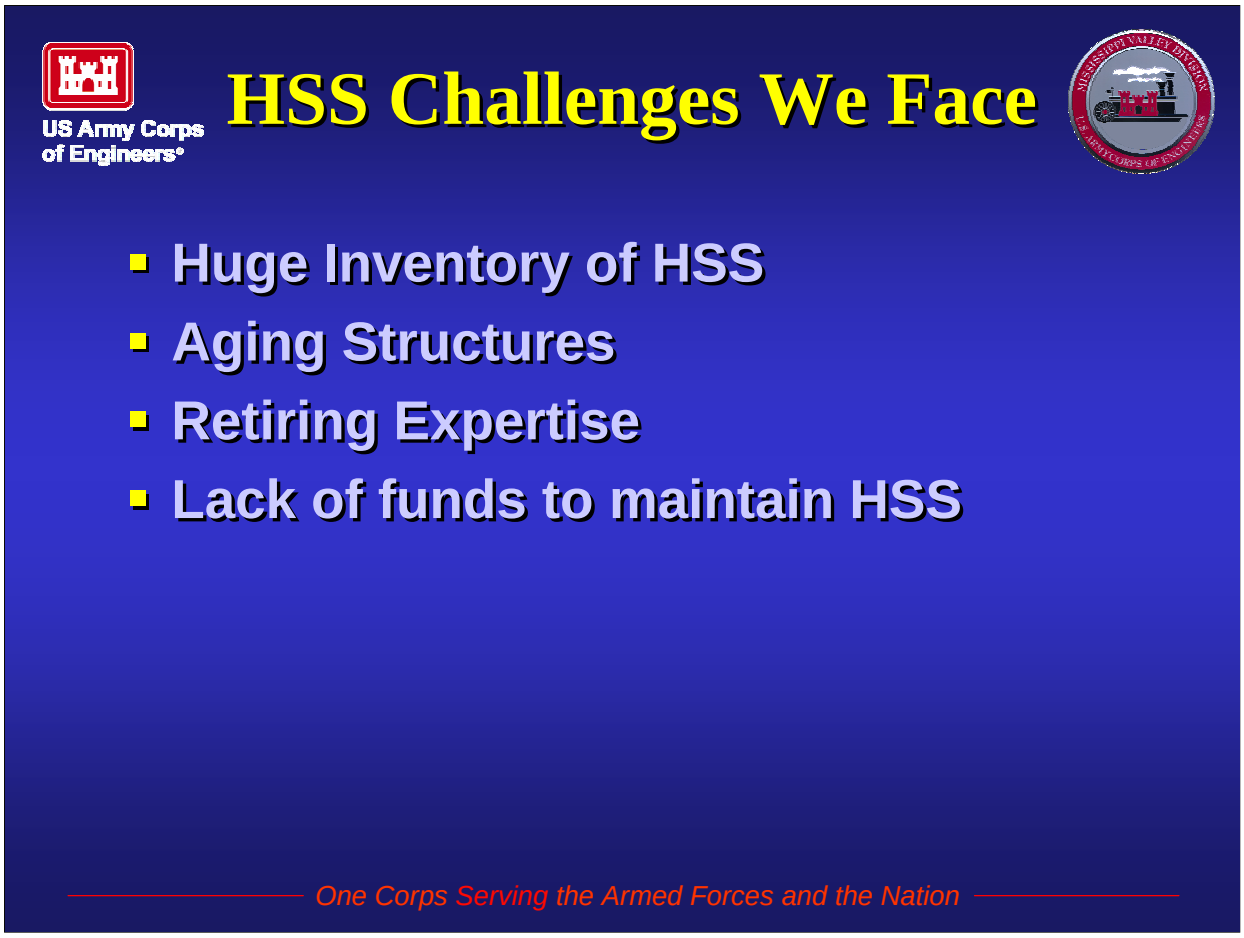
2. CONSTRUCTION

3. DURING OPERATION

MANY PEOPLE THINK HSS IS JUST AN INSPECTION REQUIREMENT DURING OPERATION.



JUST READ THRU AND DESCRIBE DIFFICULTY FINDING THIS TYPE EXPERIENCE.



IN MVD THE NUMBER OF HSS IS IN THE THOUSDANDS.

MVP >800

MVR 400

MVS > 300

MVK > 400

MVM ?

MVN ?

ERDC IS WORKING ON AN AUTOMATED SYSTEM THAT WILL ALLOW US TO KEEP UP WITH OUR INVENTORY OF HSS.

MANY OF OUR STRS WERE BUILT IN THE 40S & 50S. THESE STRS ARE OVER 50 YRS OLD. THESE STRS AREN'T GOING TO LAST FOREVER.

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Why is design, inspection, and repair of HSS so important?

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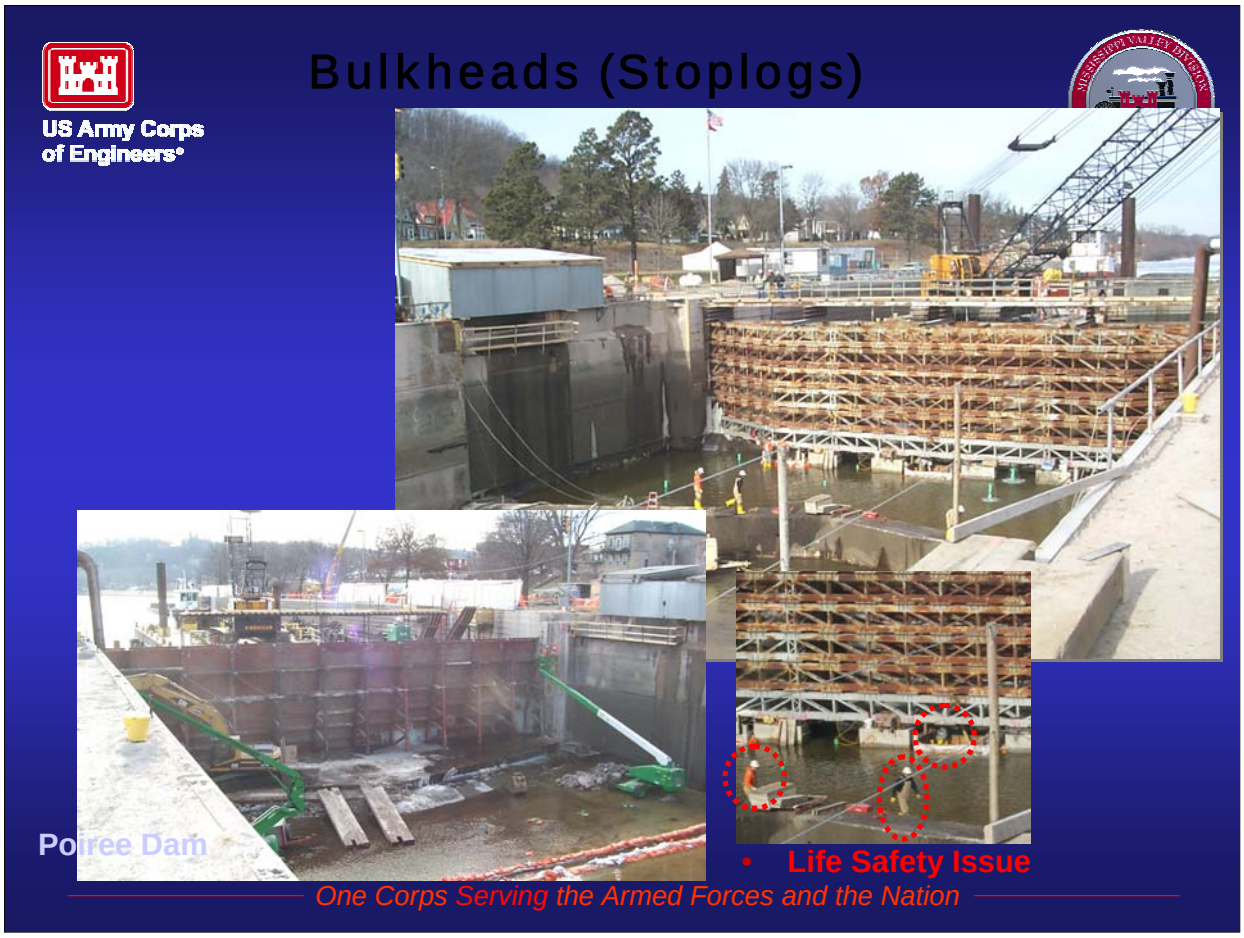


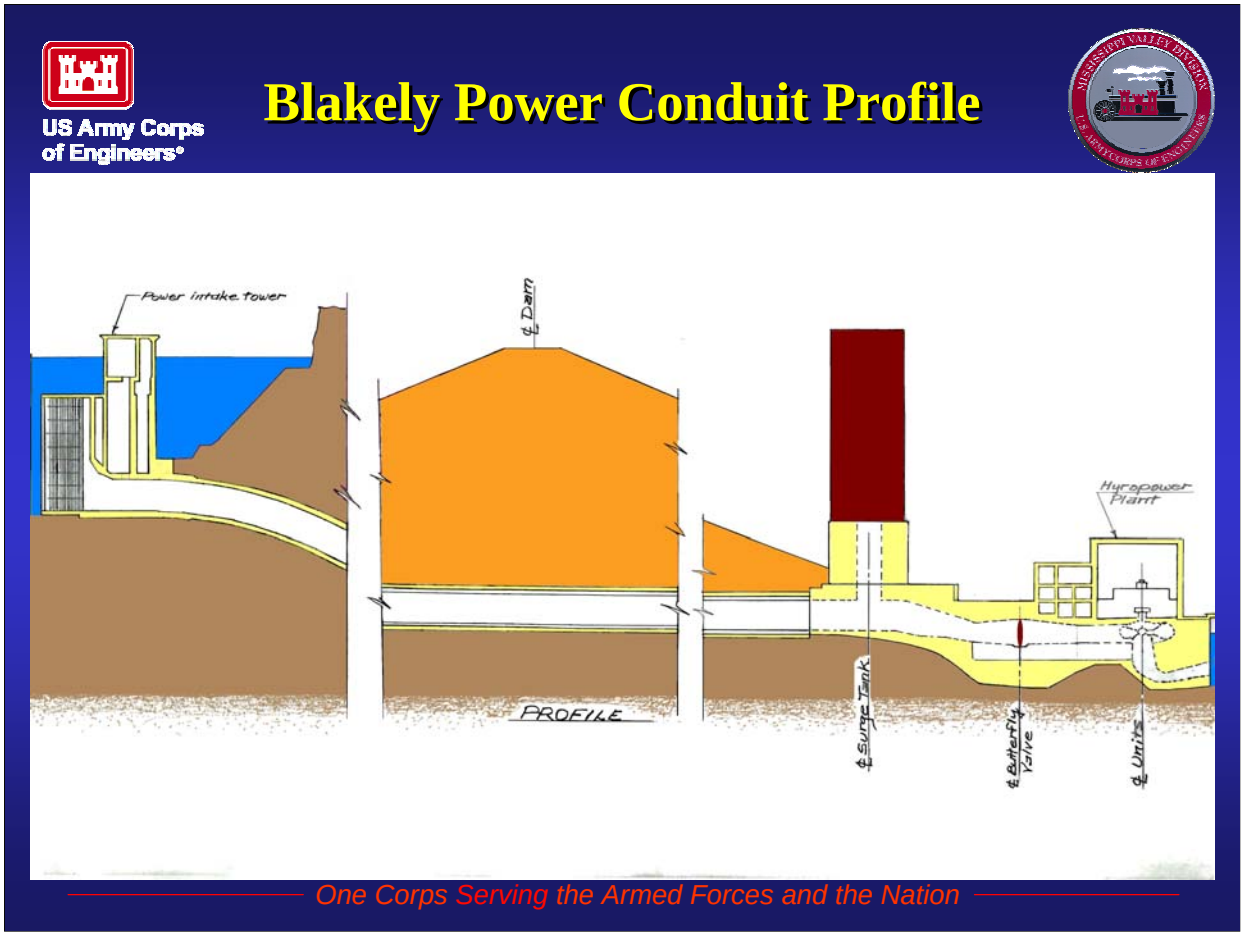
THIS PICTURE SUMS IT UP. IF YOU LOOK CLOSE YOU CAN SEE MEN WORKING IN THE LOCK CHAMBER. IF THESE BULHEADS FAIL, THESE MEN DON'T HAVE A CHANCE. IN MVD WE HAVE 67 LOCK CHAMBERS AND 37 OF THEM ARE OVER 75 YRS OLD. THEY ARE IN NEED OF MAJOR MAINT.

HOW DOES HSS RELATE TO HYDROPOWER?

READ SLIDE

LET'S USE THE BLAKELY MTN POWERPLANT AS AN EXAMPLE TO DESCRIBE SOME HSS FEATURES AND LOCATIONS

POINT OUT INTAKE AND PLANT.



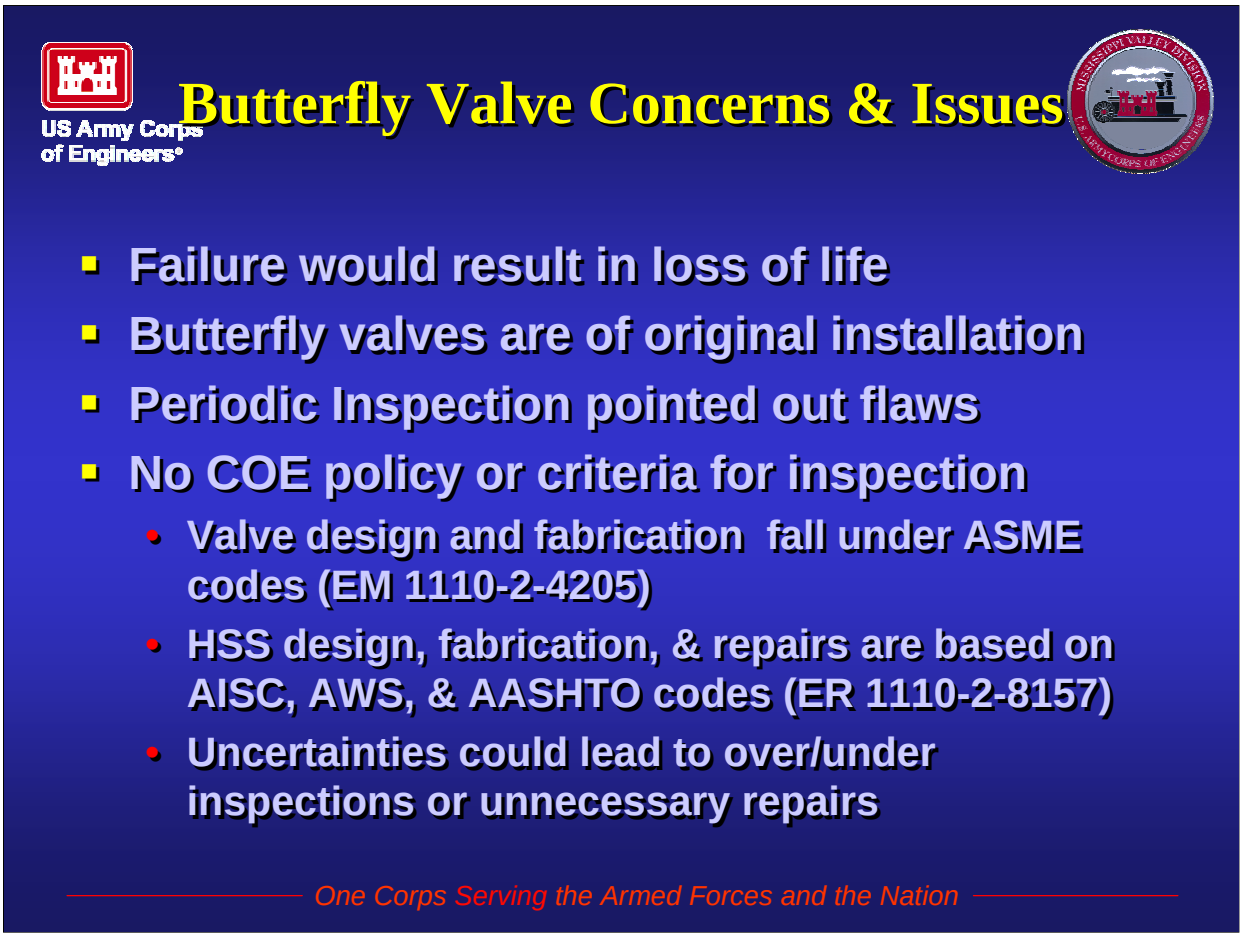
THIS IS A PROFILE THRU THE POWER CONDUIT. THIS DAM HAS 175' OF HD. ON IT. IN THE POWER INTAKE YOU HAVE THE POWER INTAKE SERVICE GATES. THESE GATES ARE NORMALLY OPEN AND USED PRIMARILY FOR INSPECTIONS AND MAINTENANCE. YOU ALSO HAVE AN EMERGENCY GATE - USED WHEN ONE OF THE SERVICE GATES IS REMOVED FOR MAINTENANCE. OBVIOUSLY, THESE GATES ARE HIGH RISK AND FAILURE WHILE SOMEONE IS IN THE CONDUIT WOULD MEAN CERTAIN DEATH.

HAS ANYONE HERE EVER PARTICIPATED IN AN INSPECTION OF A CONDUIT?

ON THE D.S. END YOU HAVE THE DRAFT TUBE GATES. LESS HEAD BUT STILL HIGH RISKS AND A PLL SITUATION.

BUTTERFLY VALVES – THESE VALVES ARE USED TO CLOSE OFF FLOW TO 1 UNIT FOR MAINT. WHILE THE OTHER UNIT CONTINUES TO GENERATE. THEY ARE ALSO USED TO CLOSE-OFF FLOW IN AN EMERGENCY SUCH AS A RUNAWAY UNIT.

MVK IS CURRENTLY WORKING ON I&E OF THESE VALVES AND THERE ARE SOME COMPLEX ISSUES INVOLVED.



We have many complex issues associated with the inspection and evaluation of the butterfly valves – one of which is policy.

Engr Issues**:** During the inspection of these valves coating was removed for spot checks. This is no surprise - when you do an inspection on something this old, you are going to find flaws. This question becomes, will this valve with flaws safely carry the loads. To answer that question an analysis must be performed. You have 2 kinds of loads: #1. dynamic loads as the valve is trying to close against flow. #2. static situation where the valve is closed. In this situation life safety is only an issue in the static situation. This makes the analysis much easier (dynamic anal is very complex & requires modeling). Since flaws were found in the inspection spot checks, the assumption will be made there are cracks in the high stress areas also. A FE analysis will be performed and stresses will be redistributed to the adjacent areas. In the 1950's the ASME code required very conservatively designs with big safety factors. Hopefully, the stress redistribution will result in stresses that are low and we feel comfortable with. If repairs are necessary it gets very tricky. With this old structure and the way they welded things in those days (welds not full penetration – plates twice thicker than needed), repairs may create propagation of cracks.

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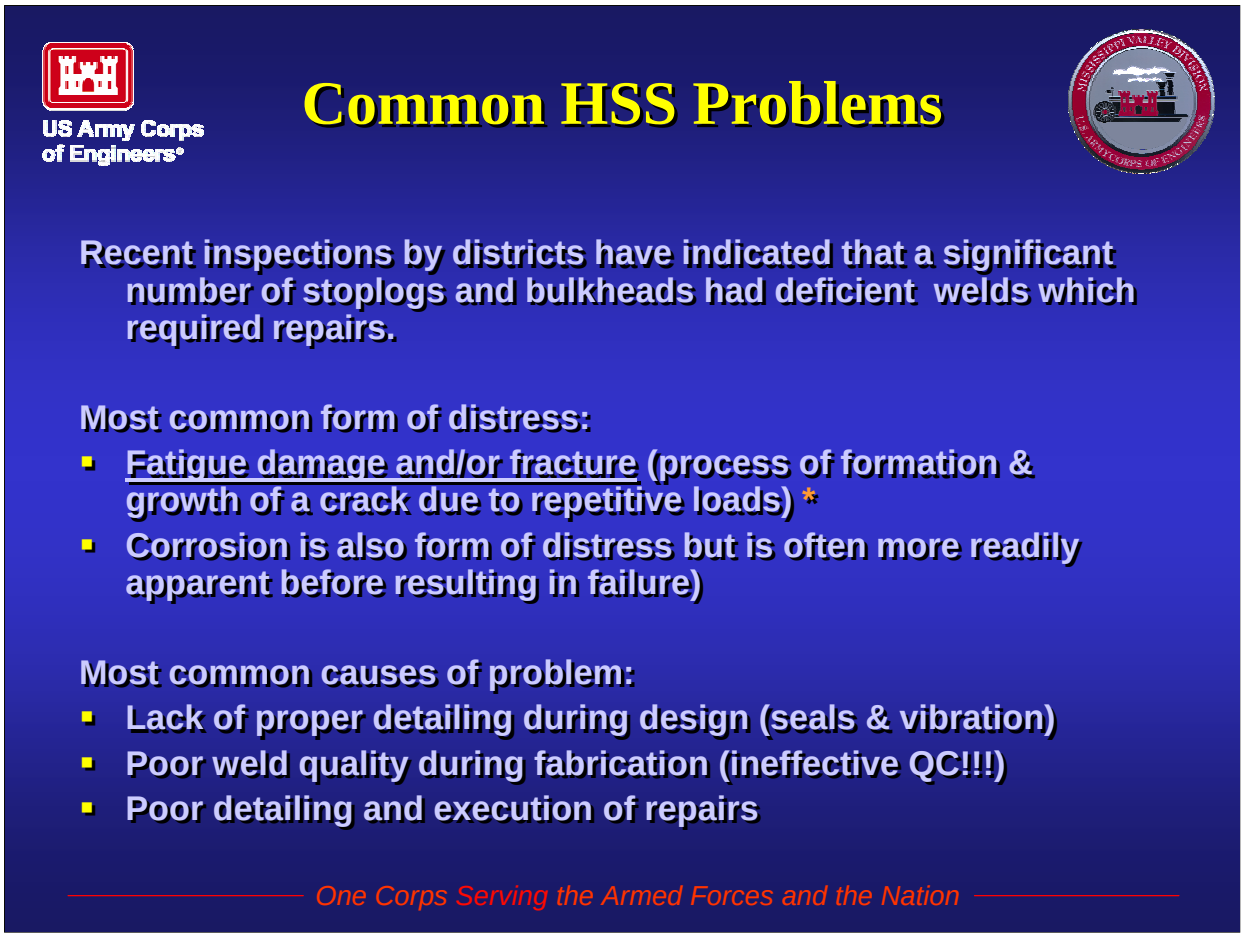
Examples of Events of Significant Distress in HSS at CW Projects

- Ice Harbor Lock Lift Gate Replacement
- Coffeeville Lock Maintenance Stoplogs Failure (Mobile District 1994)
- Melvin Price Lock Lift Gate Replacement
- Upper Miss. Lock No. 27 Lift Gate
- Maryland Lock Miter Gate Repairs
- Folsom Dam (Bureau of Reclamation) Tainter Gate Failure



OVER THE LAST 10 YRS OR SO INSPECTIONS HAVE FOUND THAT A SIGNIFICANT NUMBER OF OUR BULKHEADS HAVE DEFICIENT WELDS.

MOST COMMON FORM OF DISTRESS IS FATIGUE – ***Read defn of fatigue & say Bridges are good Example***

MOST COMMON CAUSE OF PROBLEM IS LACK OF QC DURING FABRICATION AND REPAIRS.

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Impacts of Failure

- Catastrophic failure of a spillway gate, lock gate, dewatering bulkhead, or emergency gate could cause uncontrolled release and/or loss of pool resulting in loss of life.
- Distress such as fatigue cracking can necessitate frequent inspections or a lengthy repair which, in turn, could delay river traffic or shut down a hydropower plant.
- The repair of damaged or failed structures will divert maintenance funds from other high priority projects.

HSS Inspection Frequency

Not all HSS are equal:

Gates whose failure would result in probable loss of life and include Fracture Critical Members (FCMs) with welds in tension are the most critical and require special testing and inspections on a 5-year cycle. Bulkheads and stoplogs used for dewatering fall into this category.

Gates that have structural redundancy and failure would not involve potential loss of life qualify for the 25-year inspection frequency.

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HSS Categories

The priority for importance is:

1. FCMs with life safety impacts
2. Other FCMs
3. Primary tension members or tension flanges
4. Primary Compression members or compression flanges
5. Secondary structural members
6. Non-structural items

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Common HSS Questions?

- What are FCMs?
- Typically, where are tension welds?
- How do you decide if it's Probable Loss of Life?

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- **Fracture Critical members (FCM) are defined as “members and their associated connections subjected to tensile stresses, whose failure would cause the structure to collapse”.**

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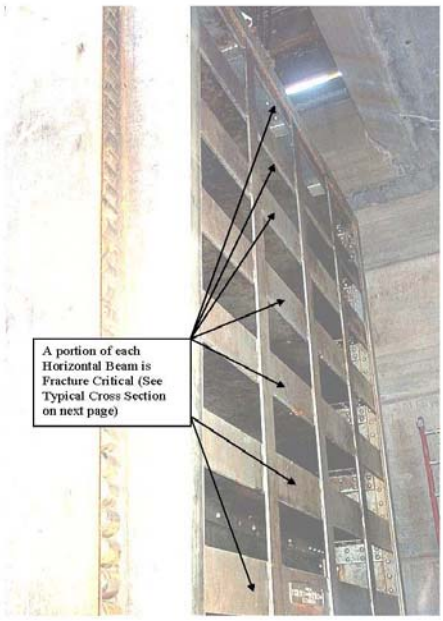
Attachment 3
Fracture Critical Members
Power Emergency Intake Gate



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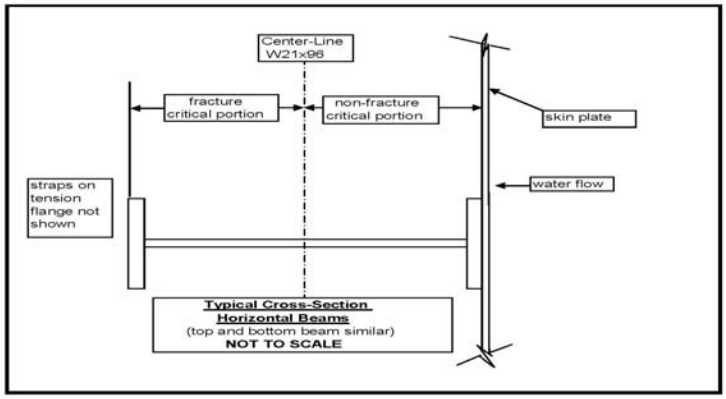

FRACTURE CRITICAL MEMBER

Cracks in welds can propagate into the primary structural member.

Inspection Issues

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- AWS requires acceptable voids/flaws to be less than a certain size based on a criteria table specified by the engineer. (criteria is different depending upon joint configuration and type of loading). This should be completed by the engineer prior to the inspection!
- Ultrasonic Testing (UT) provides method of testing to find flaws (only full penetration welds can be UT'd) (use visual and mag. particle for fillet welds)
- Need qualified UT technician
- AWS D1.1 requires welds with UT to be clean, free of weld splatter, paint, etc.
- AWS D1.1 requires visual exam prior to UT – for assurance of fit-up etc.
- NDT technician needs a smooth surface to make a good inspection
- To allow good NDT, full length of weld must be accessible
- As a result – our inspections do not truly meet AWS requirements (paint, joint configuration, access, etc.)

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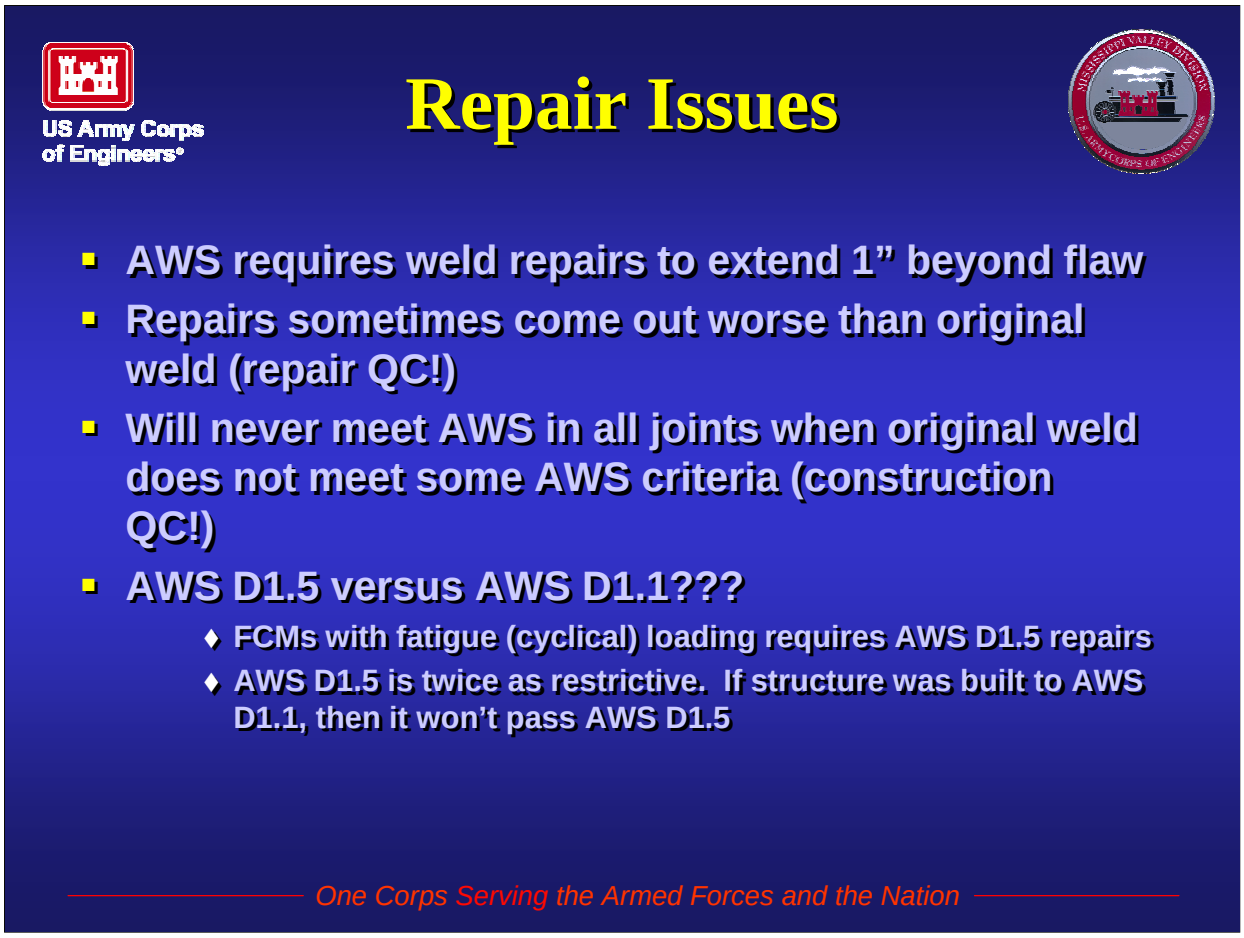
SOME ENGR HAS TO BE DONE BEFORE THE INSPECTION. THE TECHNICIANS THAT TEST THE WELDS NEED TO KNOW WHAT WELDS TO FOCUS THEIR ATTENTION ON AND WHAT FLAW SIZE IS ACCEPTABLE. THE TECHNICIANS DON'T DECIDE IF THE WELD PASSES OR FAILS – THEY DECIDE IF IT MEETS THE AWS CODE BASED ON CRITERIA ESTABLISHED BY THE ENGINEER.

IF FULL PENETRATION WELDS, UT IS REQUIRED. THE AWS REQUIRES REMOVAL OF PAINT FOR THIS TYPE TESTING. MOST OF THE TIME THAT'S NOT PRACTICAL; THEREFORE, OUR INSPECTIONS DO NOT TRULY MEET AWS REQUIRMENTS. HOWEVER, YOU CAN GET UT READINGS THRU THE PAINT BUT MUST HAVE A GOOD TECHNCIAN THAT KNOWS WHAT HE IS DOING.



READ THRU SLIDE

OPTIONAL INFO: AWS D1.5 WAS WRITTEN FOR FABRICATION OF NEW BRIDGES AND ADDRESSES CONTROL OF PARAMETERS THAT CAN LEAD TO FATIGUE DAMAGE AND FRACTURE. ELEMENTS OF D1.5 CAN BE APPLIED TO EXISTING STRS BUT MUST BE DONE WITH GREAT CARE & UNDERSTANDING OF WHAT NEEDS TO BE DONE AND WHY.

AWS D1.1 IS GENERALLY ACCEPTABLE FOR REPAIRS IF FATIGUE & FRACTURE ARE NOT A CONCERN.

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HSS Future

- What changes are expected
  - ER 1110-2-8157 (responsibility of HSS) is being updated
  - EM 1110-2-2105 (design of HSS) is being updated (compression testing?)
- ERDC developing automated tool for inventory
- Should we duplicate Bridge Safety Program?

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Questions and Comments?

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