Q. With respect to "Operating Experience", are there any records or reports summarizing " the frequency and severity of operating problems and failures" that are said to have been increasing in recent years?

A. The frequency and severity issues, for the most part, are recorded in equipment failure reports, overhaul documentation, and entries related to completed work orders. There is no current summary of these occurrences as such. However attached is a log of #2 Boiler tube failures that was recently compiled for the Department of Government Services, Boiler and Pressure Vessel Branch, and outlines the increases in these failures since 1993. Also attached is correspondence from Alstom's Manager of Engineering referencing the condition of #2 boiler waterwall tubes and their life expectancy.

Holyrood Thermal Generating Station
Unit 2 - Tube Failure Log

Failure Date	Location	Repaired By	Repaired Date	Repair / Failure Report	Cause	Failure Analysis Company	Failure Analysis Report Reference	Comments
06-Sep-93	WW above 3D burner.	NLH	06-Sep-93	NA	NA	NA	NA	Tube was repaired using Tube Window Patching Method. Work was carried out under repair procedure 93-P120.
30-Nov-02	Final HTSH Section, Platen # 7 from east	Alstom	6-Dec-02	20-Jan-03	Stress corrision cracking and external wastage	Alstom MTC	MTC-03-046	Failure occurred in a stainless steel bend. Replacement material supplied by Alstom on emergency basis. A second bend required replacement due to distortion. Platen # 8 was distorted from failure but was not replaced.
30-Apr-04	Final HTSH Section, Platen # 7 from east	Alstom	3-May-04	11-May-04	External wastage and possible SCC	Alstom MTC	MTC-04-200	Same assembly as previous failure however in a different tube. Failure occurred shortly after start-up of the unit. Failure located close at return bend. Replacement material was supplied by Alstom on emergency basis.
7-Nov-04	Final HTSH Section, Platen # 7 from east	Alstom	10-Nov-04	see 2002 Outage Report dated February 7, 2005	Stress corrision cracking	Alstom MTC	MTC-05-032	Leak found during service pressure test after completion of overhaul. Failure was in the down-stream weld that was completed in May 2004. Failed on new tube-side of weld.
7-Nov-04	West WW 1st floor at attachment weld to north casing	Alstom	10-Nov-04	see 2002 Outage Report dated February 7, 2006	Stress crack at casing attachment weld	NA	NA	Leak found during service pressure test after completion of overhaul. Tube was repaired. Replacement was not possible unless removed from header. No swage available. Suspect that this was leaking for some time but hidden under the ash. Leak was into furnace on furnace side of casing.
13-Nov-04	Final HTSH Section, Platen # 7 from east	Alstom	17-Nov-04	see 2002 Outage Report dated February 7, 2007	Stress corrision cracking	Alstom MTC	MTC-05-032	Leak occurred in down-stream weld that was completed November 10th. Again failed on new-tube side of weld.
22-Feb-05	SSH	Alstom	26-Feb-05	10-Mar-05	Thinning due to exterior corrision	NA	NA	Platen 7 from east in final section.
13-Apr-05	North WW	Alstom	15-Apr-05	July,05	Underside Corrosion	NA	NA	Slight bulge and longitudinal crack. Located at top of burner elevation. Should look for additional during outage and take sample.
13-Apr-05	West WW	Alstom	15-Apr-05	July,05	Underside Corrosion	NA	NA	Slight bulge and longitudinal crack. Located at top of burner elevation. Should look for additional during outage and take sample.
15-Apr-05	East WW	Alstom	15-Apr-05	July,05	Underside Corrosion	NA	NA	Same as above two failures. Found during service pressure test of previous repair.
18-Apr-05	Economizer Tube - 3rd row from west, 2nd row down	Alstom	4/20/2005	Aug,05	longitudinal crack near support	Alstom MTC	NA	Failed tube was removed from service by plugging at the inlet and outlet headers. Failure removed for analysis.
25-Apr-05	SSH	Alstom	?	?	?	?	?	?

Last Updated : 9/13/2006

ALSTOM

Power Service

Newfoundland & Labrador Hydro

February 6, 2006

Attention: Terry LeDrew
Manager,Thermal Generation

Further to our meeting at Hydro Place on February 1, 2006, ALSTOM was requested to comment on the risks and consequences of further tube failures as a result of the discussion and the action plan being instituted for unit #2. The plan includes a replacement of waterwall sections which will include the affected tubes. As this replacement will not occur for two months, a review of possible risks of additional tube failures in this two month window is outlined below.

Fire Side Tube Failures

The failure mechanism associated with the recent waterwall tube failures is overheating caused by internal deposits. These deposits insulate the tube from cooling, and combine with the heat flux from combustion to overheat the tube locally. It is important to note that not every tube is affected, as it has been seen that the majority of the tubes in the affected area show no signs of wall thinning. This failure mode can only occur on the fire side of the waterwall as it is driven by the heat flux of combustion. It can not occur on the casing side on the boiler.

The failure manifests itself either by forming a blister, which cracks and causes a leak, by thinning the wall of the tube through wastage to the point of producing a pressure failure, or by hydrogen attack caused by overheating together with the corrosive environment under the internal deposits on the fireside of the tube.

The recent inspection of the east wall found a total of 38 blisters. The failure which caused the most recent outage was due to hydrogen attack, and there were no tube failures due to wall thinning.

As it has been determined that the internal deposits range from "very difficult to virtually impossible" to remove chemically (Northland Consulting Ltd. Letter of January 26, 2006), the only way to reduce the risk of additional failures in the next two months is to reduce the heat flux to the affected wall area. Actions are being instituted which will accomplish this.

1430 Blair Place, Suite 600
Ottawa, Ontario, Canada
K1J 9N2
Tel.: (613) 747-5222
Fax: (613) 747-5888

ALSTOM Canada Inc.

With regard to the probability of another fireside tube failure occurring in the next two months, until the affected tubes are replaced, the potential still exits for another failure. However, recent and future actions will reduce this probability.

1. In the past three weeks an extensive inspection has been carried to isolate the boundaries of the damage and identify each tube that required repair/replacement. UT inspection, RT inspection, and internal boroscope inspection has resulted in a detailed mapping of the condition of each and every tube in the affected area. Although it is known that there are some tubes that remain with wall thickness less than 0.140" MWT, and it is possible that there are some tubes that may have hydrogen damage that was not detected, the thorough inspection has resulted in repairs and replacement of the blisters, cracks, and excessively thinned tubes (less than 0.100").
2. The predicted tube mid wall temperature is about 720°F, which is based on a clean tube. The damage that is being seen indicates that the metal temperature must be at least 900°F. This extra temperature is the result of the insulating effect of the internal scale. By operating the unit at 60MW or lower and reducing the drum operating pressure from 2050 psi to 1700 psi, the predicted metal temperature will reduce by 52°F. This reduction is due to a lower saturation temperature from the pressure reduction combined with a lower heat flux from the load reduction.
3. Another action that is being instituted is a change to the firing practice whereby only the lower elevation of burners would be placed in service and they will be placed in a downward tilt position. Also, multiple burners will be used. This action will further reduce the heat flux to the waterwall tubes in the affected area. This will result in a minor reduction of about 5°F in the tube temperature.
4. The combination of items 2 and 3 above will have a net affect of reducing the tube metal temperature by 57°F. This will provide an increased margin of protection as the ASME Code minimum wall requirement will drop from 0.191" MWT to 0.136" MWT based on the 2004 ASME Code. Thus, by reducing the tube temperature, the potential for further overheating failures is reduced.
5. Base on the ASME Code required wall thickness of 0.136" as indicated in item 4 above, 70% of this thickness is 0.095". There are currently no tubes that have a wall thickness below 0.100" .
6. The unit was recently subjected to two service pressure tests of 1885 psi. By reducing the operating pressure to 1700 psi, the waterwall tubing will be operating at a pressure about 10% below the successful service pressure test.

Although the above actions will not eliminate the risk of another fireside tube leak, this risk is reduced considerably by the detailed inspection/repair/replace actions and the limitations imposed on the future firing/operational practice.

In addressing the consequences of another leak, a couple of points need to be considered.

1. A fireside tube leak or failure does not affect personnel safety as the failure is completely contained inside of the boiler.
2. There have been two failure modes experienced from the overheating, cracks in blisters, and a blow out from hydrogen damage. To date there have been 38 blisters discovered and one (1) hydrogen blow out. The consequent of a blister crack occurring may not cause a unit outage if the crack is small enough not to affect the boiler operation. Of course, a large or multiple cracked blisters may cause an outage. A hydrogen blow out will definitely cause an outage.
3. The action plan also includes restricting access to this area, which will also provide safety assurances.

In summary, the worst case scenario would be a boiler outage and personnel safety is assured.

During our meeting, the possibility of adding refractory to the waterwall to reduce the tube metal temperature was discussed. Refractory has been added to waterwalls in the past to protect the walls from erosion and abrasion, and to act as a heat sink to retain the heat in the bottom of a bark fired industrial boiler for better combustion of moist fuel. The addition of refractory to protect waterwalls from overheating has not been done previously. As the current action plan provides for a replacement waterwall in two months, the practicality of the time and cost required to obtain the refractory material, and the time and cost required to install same for a two month operational period must be considered when weighing the risks. As noted above, the consequence of an additional failure will be a boiler outage which will require a tube replacement.

Casing Side Tube Failures

The recent tube failures, as described above, are isolated to the fireside exclusively. As there is no heat flux on the casing side, this type of failure can not happen on the outward side of the tube.

Failures that can occur on the casing side include corrosion fatigue, failures at points of attachments, original tube defects, pitting corrosion, etc. The risk of this type of failure occurring is no greater on this unit than any other 35 year old oil fired utility and the recent fireside failures do not increase this risk.

Membrane Failures

The membrane between two adjacent tubes is cooled by conduction from the tubing. Although some tubes have suffered from overheating, this is local to the crown of the tube, or close to the crown. The membrane is attached to the tube 90° away from the crown, where the tube midwall temperature is lower. Therefore the membrane should still have adequate cooling and will not experience elevated temperatures.

Therefore, there is no risk of a membrane failure caused by the same failure mechanism as the recent fireside failures.

John McMillan P.Eng.
John McMillan, P.Eng
Manager, Engineering