Relaxation of Pressure and Temperature during HELBA for Subcompartment

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Abstract -This study is to present the relaxation of the pressure and temperature(P/T) for Subcompartment during Main Steam Line Break (MSLB). The double-ended MSLB in the steam bunker corresponds to the limiting accident in the point of maximum P/T. The analysis results for the steam bunker with LOFTRAN-COMPARE for M/E and P/T, respectfully, show that the maximum pressure difference is 1.45bar and the maximum temperature is 250°C. The temperature is too high to qualify the equipments for these environmental Temperature (generic limit 182°C) conditions. It is recommended to optimize the temperature result. To do so RELAP-TRAPSCO are used to analyze mass/energy (M/E) release and P/T. Finally, the result of RELAP-TRAPSCO shows that the peak temperature is lower than that of LOFTRAN-COMPARE.

1. Introduction

It represents the nodalisation of the Steam Bunker and the results of the differential pressurization following a steam line break. The note presents also the temperature evolution in some node of the building.

It has been discussed that the use of a short term differential code is not especially appropriate to calculate temperature evolution in a system of nodes, because there is no heat transfer calculation, either by conduction or by convection (Fan). However it is obvious that the too high temperature obtained in the calculation with the code COMPARE are not realistic. The purpose of the investigation is to determine the origin of this unrealistic temperature behavior by calculating the same transient with the code TRAPSCO. The code TRAPSCO is used by Tractebel Engineering to calculate differential pressurization in a system of nodes linked by junctions.

The volume and junction data representing the steam bunker have been put in form to satisfy the syntax of input data to the code TRAPSCO.

2. Mass & Energy Release Data Generation

The MSLB Mass and Energy Releases, inside/outside Containment, was generated with LOFTRAN. The superheating of the vapor has to be accounted for by a specially designed method when the upper part of the Steam Generator(SG) tubes is uncovered. This method is not necessary when other code than the LOFTRAN code is used to calculate the M/E release. For example, with the RELAP code, such a method is not needed since the nodalization is naturally adapted to model this phenomenon.

After presentation of the USNRC IN 84-90 (MSLB Effect on Environmental Qualification of Equipment), it was confirmed that this information note is not binding since it is dependent on the method used by Westinghouse to carry out the calculations. The method used in LOFTRAN requires several parameters to be input in order to account for the superheated vapor.

Concerning the temperature curve limit, it was mentioned that the RELAP-TRAPSCO calculations show that this limit is not reached. This is thought to be caused by the use of the RELAP code rather than by the LOFTRAN code for calculation of the M/E release data.

3. P/T Analysis

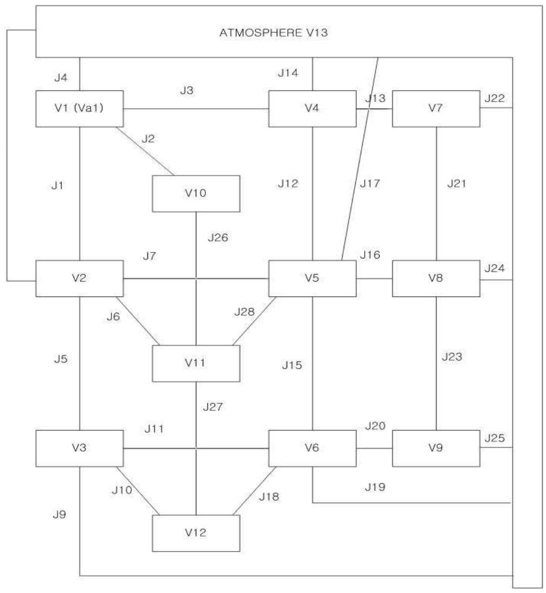

Fig 1 Nodalization of Steam Bunker

Since there is no heat transfer in the code COMPARE as well as in the code TRAPSCO, the calculated temperature will certainly be conservative, without knowing by how much it will be conservative. More than expected, COMPARE gives temperatures which rise above the saturation line, in the superheated domain. It is needed to be able to find the origin of this temperature increase, far above what was normally expected of these calculations.

Fig. 2 is a graph presenting the results of TRAPSCO for the temperatures reached in volumes 5 to 8.

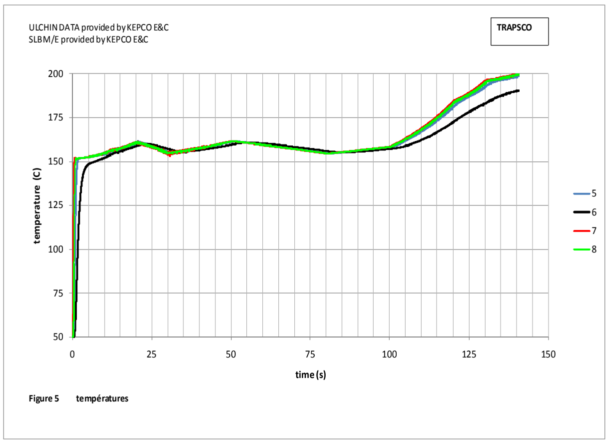

Fig 2 Results of Temperature Analysis for Steam Bunker (LOFTRAN-TRAPSCO)

In all the subcompartments, the temperature begins to rise at around 100s and reaches about 200 °C in the injection subcompartment. This finding is in agreement with what was found by LOFTRAN-COMPARE. Conclusion of this investigation, the temperatures calculated by COMPARE and TRAPSCO have a similar trend.

It was decided to simplify the model of the bunker by keeping only 4 nodes (the node 7, the two connected nodes 4 and 8 and the node representing the atmosphere). The junction areas, loss coefficients and inertia are unchanged. The break is assumed to occur in node 7. The nodes and junction have been renumbered. The new nodes 1 and 3 are assumed to be also at the atmospheric pressure.

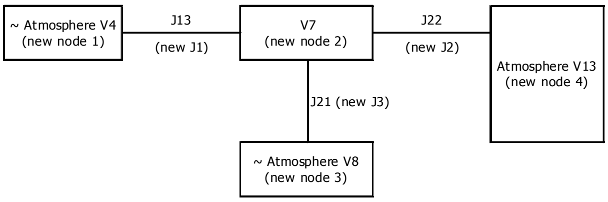

Fig 3 Simplified Nodalization (Stem Bunker)

With this simplified model, it is possible to calculate the temperature reached in volume 7 (new node 2) during 200 s or more. The results of pressure and temperature in node 2 (where the break occurs) and the steam mass flows in the junctions are depicted in the figures Fig. 4 and 5. The pressure reaches a peak of 1.5 bara.

The temperature profile reaches a value of 115°C during the first 5 seconds, then follows a period (5 s to 14 s) in which the value of 100°C is maintained. Thereafter the temperature rises to reach a plateau of 121.5°C which lasts until 165 s when the temperature increases again to 135 °C and remains constant.

A sensitivity test is carried out to examine the impact of the M/E on the maximum temperature reached in the bunker.

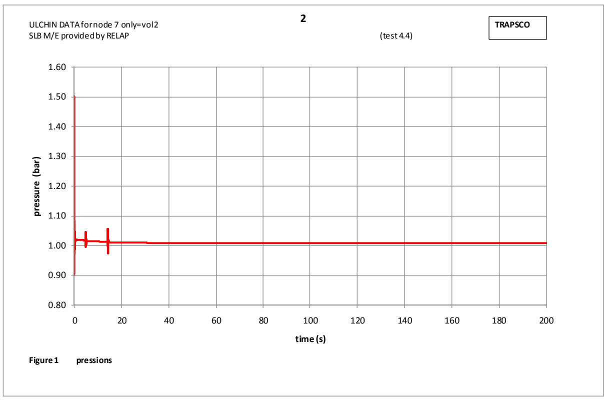

Fig 4 Pressure on Steam Bunker(RELAP-TRAPSCO)

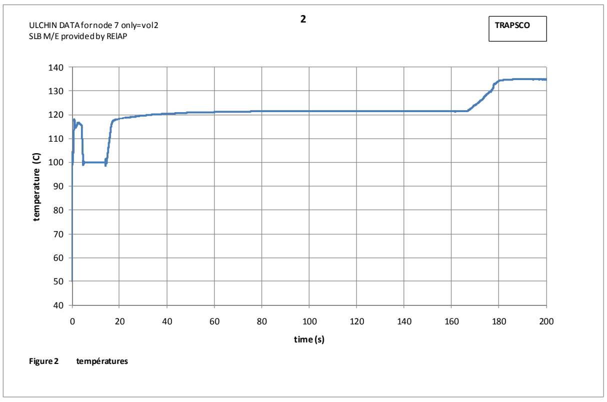

Fig 5 Temperature on Steam Bunker(RELAP-TRAPSCO)

In order to verify this hypothesis, the model of the SG in the RELAP deck is modified. The volume of the SG dome is increased by a factor of 2. This increases the dome area, thereby reducing the potential liquid droplets velocity at the exit of the SG. In this way, it becomes possible to investigate the impact of the break quality on the final temperature in the building.

4. Conclusions

In conclusion, the peak temperature of Steam bunker is calculated 135°C with RELAP-TRAPSCO. From the comparison RELAP-TRAPSCO and LOFTRAN-COMPARE for M/E and P/T analysis, it is known that the method of M/E release by the code LOFTRAN is conservatively high because of enthalpy from superheated steam.

REFERENCES

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[3] Tractebel Engineering, Methodology of MSLB, (2004).