13th World Conference on Earthquake Engineering
Vancouver, B.C., Canada
August 1-6, 2004
Paper No. 1288

SEISMIC EVALUATION OF TEHRAN OIL REFINERY

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SUMMARY

Importance of industrial facilities and their vulnerability to earthquake motions have been shown in just about any earthquakes though out the world. Iran being a major oil producing country with substantial amount of investments placed on the production, storage. Processing and transport of this natural produce from on side, and the high seismically of Iran from other side, has made the seismic vulnerability assessment of theses facilities a priority number one for the country.

Unfortunately, for a long time due to organizational problems, getting starts in this very important task was delayed until last year, the beginning of year 2000. The triggering point for this action stated with the establishment of a disaster management committee for controlling the Y2K virus. Consequently. After this successful operation, the committee extended its activities further to man made and natural disaster as well.

This paper will discuss the organization of this committee, as well as the general established for the assessment and management of the problems of the problem if arises. Many of the facilities are designed to standards set for earthquake resistance. However, new seismic codes mandate harder loading conditions, which require assessment of these facilities against new conditions. In city of Tehran alone, there exists about 100-gas station, 50 km long 8 in and 12 in piping for distribution and more than 100,000 sq.m of office spaces belonging to oil facilities. All these facilities are being studies and investigated for potential earthquake, which is the main discussion of this paper. This paper will provide, planning and assessment results obtained so far in this project.

INTRODUCTION

Iran is a country prone to many destructive earthquakes. Historical evidence has shown that in about every 150 years, there has been a major earthquake effecting Tehran region with very destructive forces. Last earthquake to hit this region was in 1830 which makes this city seismically very vulnerable. In this regard, city officials are extremely concerned. To address this concern, oil and refinery officials have lunched a major project in order to assess the seismic vulnerability of the Tehran refinery which is located in southern part of the city. This paper looks at the assessment process and preliminary results obtained.

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This refinery was built and operated in 1936 with original design and construction by Fluore Company. It worth noting that this very refinery has also experienced Iran-Iraq war in which much destruction during the war was imposed onto the refinery. These structural failures were then repaired by local officials to the best available methods in order to continue with the operations.

METHOD OF ASSESSMENT

To assess the seismic vulnerability of petrochemical facilities around the world, there has been very little assessment techniques developed. The most widely used procedure is the one developed by the ASCE Task Committee on Seismic Evaluation and Design of Petrochemical Facilities. This technique is totally depended on side walk and visual screening evaluation procedures. Few other attempts have been also tried by other task committees which basically follow the ASCE recommendations with few modifications.

In this regard, Tehran project also was lunched by the same format as stated by ASCE but along the way few major modifications and changes were added to the recommendations. Major changes being, a) establishment of numbering technique to convert and unify all the results by normalizing qualitative findings into quantitative results, and b) use of simplified analytical calculations whenever screening techniques were inadequate to predict the true vulnerability. In general, flow chart given in Figure-1 was used to reach the final assessment for each components as well as processing unit as a whole.

As shown, following factors were to establish during this evaluation:

1) Evaluation of the Site Hazard
2) Evaluation of the Component Performance
3) Assessment of overall Unit Performance
4) Loss Computation
5) User Friendly Presentation of Seismic Vulnerability

CONSIDERED UNITS IN TEHRAN REFINERY

To have a full seismic assessment of the refinery, following units were evaluated:

1. Atmospheric Distillation Unit
2. Vacuum Distillation Unit
3. Liquid Petroleum Gas Unit
4. Visbreaking Unit
5. Gas reformer
6. Hydrogen Unit
7. Isomax Unit
8. Kerosene Unit
9. Nitrogen Plant
10. Sulfur Plant
11. Utilities.

Each unit was inspected very carefully using pictorial means. Then, evaluation forms were filled up for each component accordingly. Figure-2 shows a typical field data form used for gathering the data. Figure-3 shows a filled up data form.

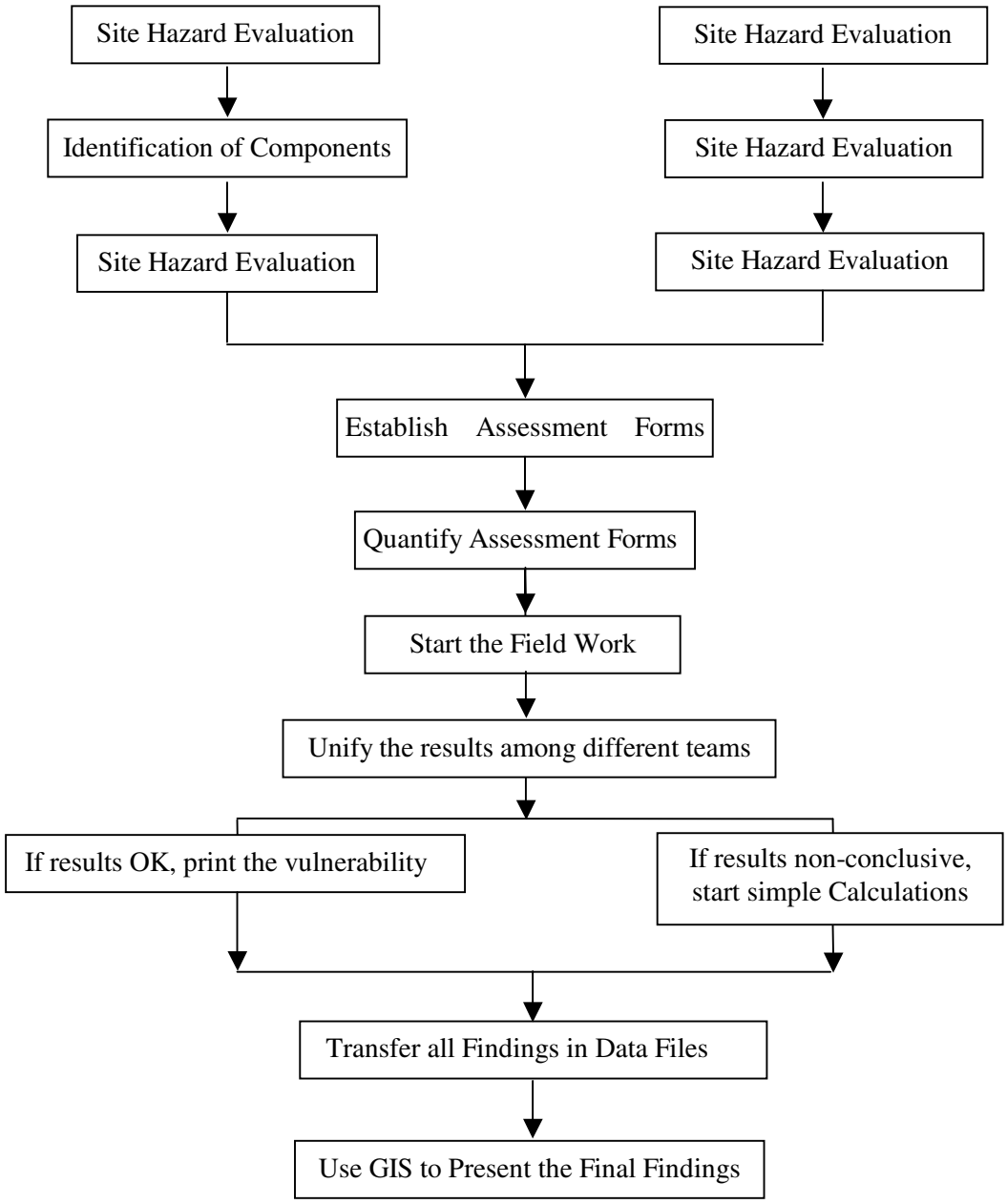

Figure 1: Flow chart used for assessment of Tehran Refinery

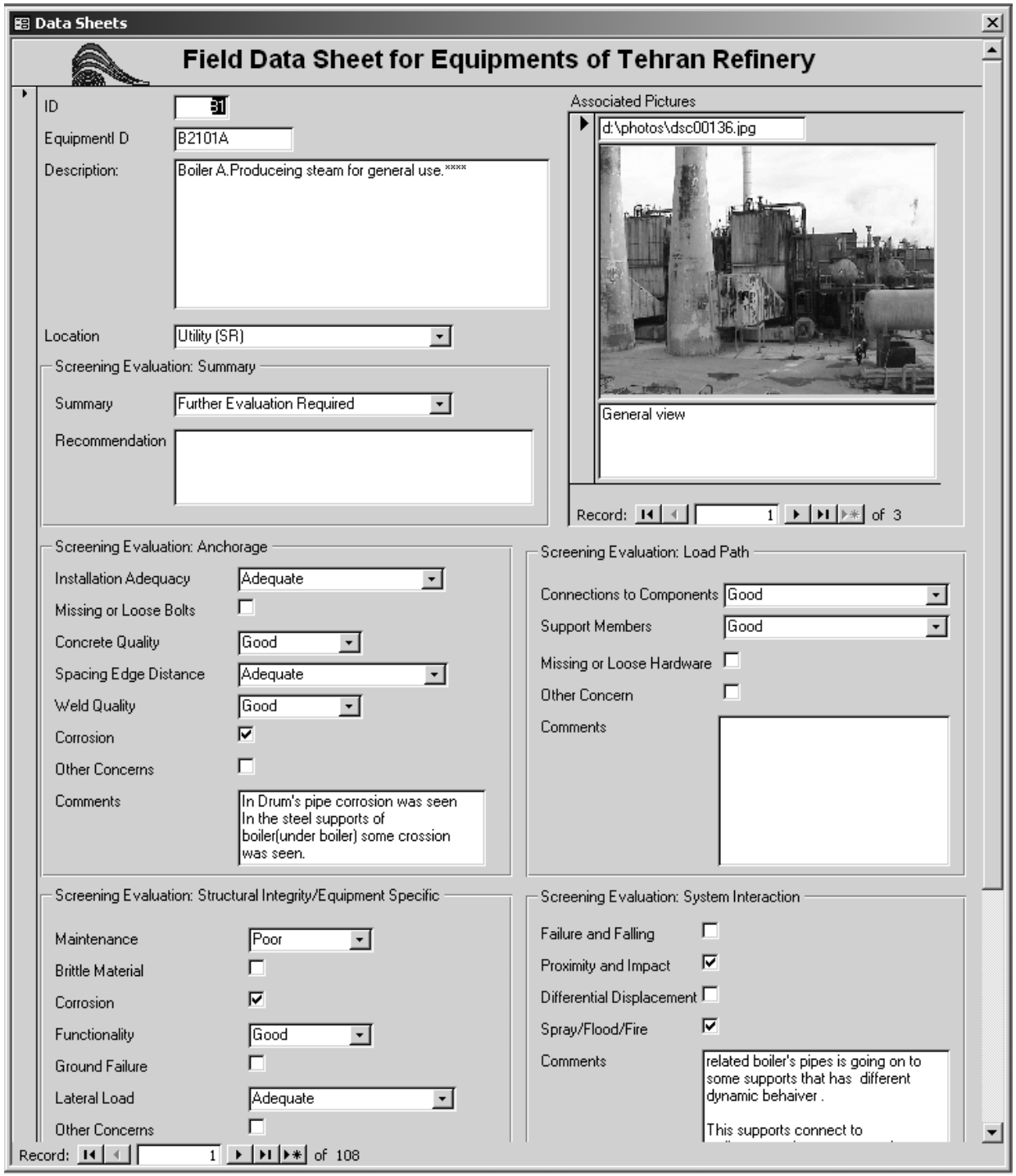

Figure 2: Field Data Form—Data Bank

Field Data Sheet report for Equipments of Tehran Refinery

General data

Location	Utility (SR)	*EquipmentID*	B2101A
Description	Boiler A Boilers produce 650psi steam for all steam turbine drivers and other refinery needs. Water comes from Dearators and goes to the Boilers.		

Summary

Summary	Adequate
Recommendation	

Anchorage

Installation Adequacy	Adequate
Missing or Loose Bolts	☑
Concrete Quality	Good
Spacing Edge Distance	Not Adequate
Weld Quality	Good
Corrosion	☑
Other Concerns	☐

Comments

In Drum's pipe corrosion was seen
In the steel supports of boiler(under boiler) some crossion was seen.

Load Path

Connections to Components	Good
Support Members	Good
Missing or Loose Hardware	☐
Other Concerns	☐

Comments

Structural Integrity/Equipment Specific

Maintenance	Good
Brittle Material	☐
Corrosion	☑
Functionality	Good
Ground Failure	☐
Lateral Load	Adequate
Other Concerns	☐

Comments

System Interaction

Failure and Falling	☐
Proximity and Impact	☐
Differential Displacement	☐
Spray/Flood/Fire	☐

Comments

related boiler's pipes is going on to some supports that has different dynamic behaiver .

This supports connect to walkways and power generation building .

Boilers have burners and it may cause fire

Additional Notes

It's stacks may fall on it and the walkway may impact it

Singnatures

First Name		
Second Name		

Figure 3: A Typical Filled up Form

DATA GATHERING METHOD

Each component within each unit was inspected in detail. For each case pictures were taken from the possible sources. Figures 4 to 8 indicates few of the existing problems.

Table 1: Seismic situations for each component

seismic situation as Equipment ID	Existing Losses	Result of Evaluation In Present Situation
2B2101A	Concrete, Corrosion, Maintenance	Further Evaluation Required
2B2101B	Concrete, Corrosion	Further Evaluation Required
2B2101C	Concrete, Corrosion	Further Evaluation Required
2B2101D	Concrete, Corrosion	Further Evaluation Required
2C201A	Concrete, Corrosion, Flood of Oil	Adequate
2C201B	Concrete, Corrosion, Flood of Oil	Adequate
2C2222A	Concrete, Corrosion, Maintenance	Adequate
2C2222B	Concrete, Corrosion	Adequate
2C251	Concrete, Corrosion, Flood	Adequate
2CT2261A	Brittle material, Falling, Fire	Not Adequate
2CT2261B	Brittle material, Falling, Fire	Not Adequate
2CT2261C	Brittle material, Falling, Fire	Not Adequate
2DA2101A	Support members	Further Evaluation Required
2DA2101B	Support members	Further Evaluation Required
2DR2221A	Concrete, Impact	Adequate
2E201C	Concrete, Corrosion	Adequate
2E201D	Concrete, Corrosion	Adequate

Figure 4: Surge drum in old sour water stripper unit

Figure 5: Boilers produce steam for all steam turbine drivers and other refinery needs

Figure 6: Deep cracks in foundation

Figure 7: The overhead from 2V-1603 at 218 psig

Figure 8: Bracings of the pipe supporting system

RESULTS AND DISCUSSION -NUMERICAL ANALYSIS

As specified earlier, some cases were almost impossible to be assessed using inspection techniques. To predict the seismic behavior of such components, it was decided to perform some modeling and calculations. The results obtained through these investigations were added to results from field inspections for final assessments. A typical model of a stack and stresses are shown in Figures 9.

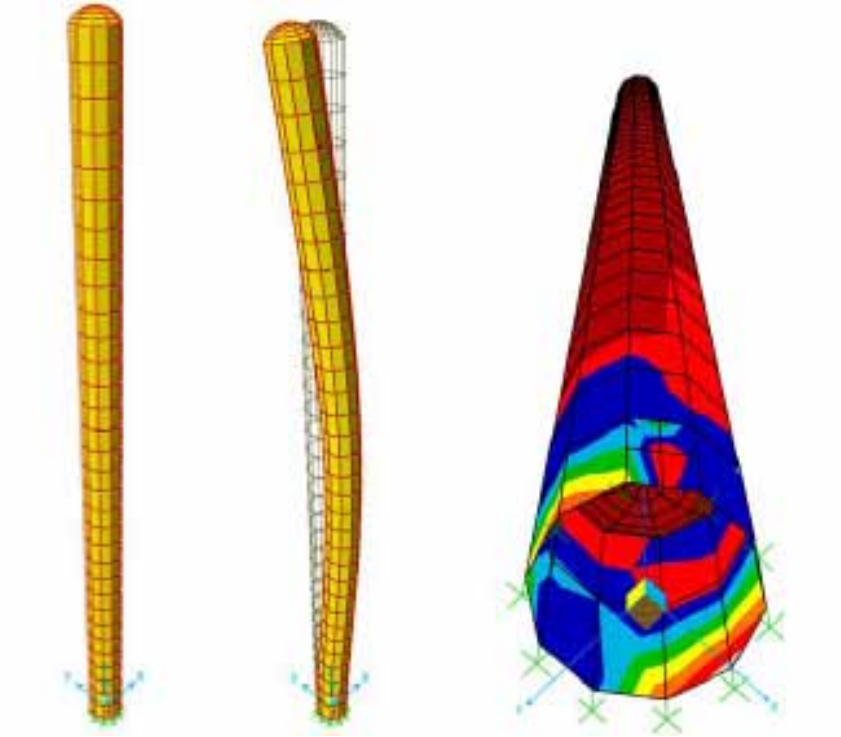

Figure 9: The finite element analytical model for high pressure amine contactor stack

CONCLUSIONS

Different units in Tehran's refinery were assessed using a combination of walk down inspection techniques and numerical calculations. Forms of evaluations were designed and used to gather information on each component in the refinery. In turn, these data were quantified using some statistical weighting functions and then used for assessment. In final assessment, for each component a table was obtained indicating its seismic situation as shown in Table-1. It is believed that after final assessment of the whole refinery, officials can start considering proper retrofitting techniques to reduce the possible risk.

REFERENCES

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