Engineers India Limited

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)





FLARE LOAD MITIGATION

Lovraj Kumar Memorial Workshop, March , 2016

AGENDA

- Objective
- Philosophy and Methodology of Mitigation
- Case Study-1: Expansion in Existing Refinery
- Case Study-2: Grass Root Refinery
- Case Study-3: Grass Root Olefin Complex
- Summary

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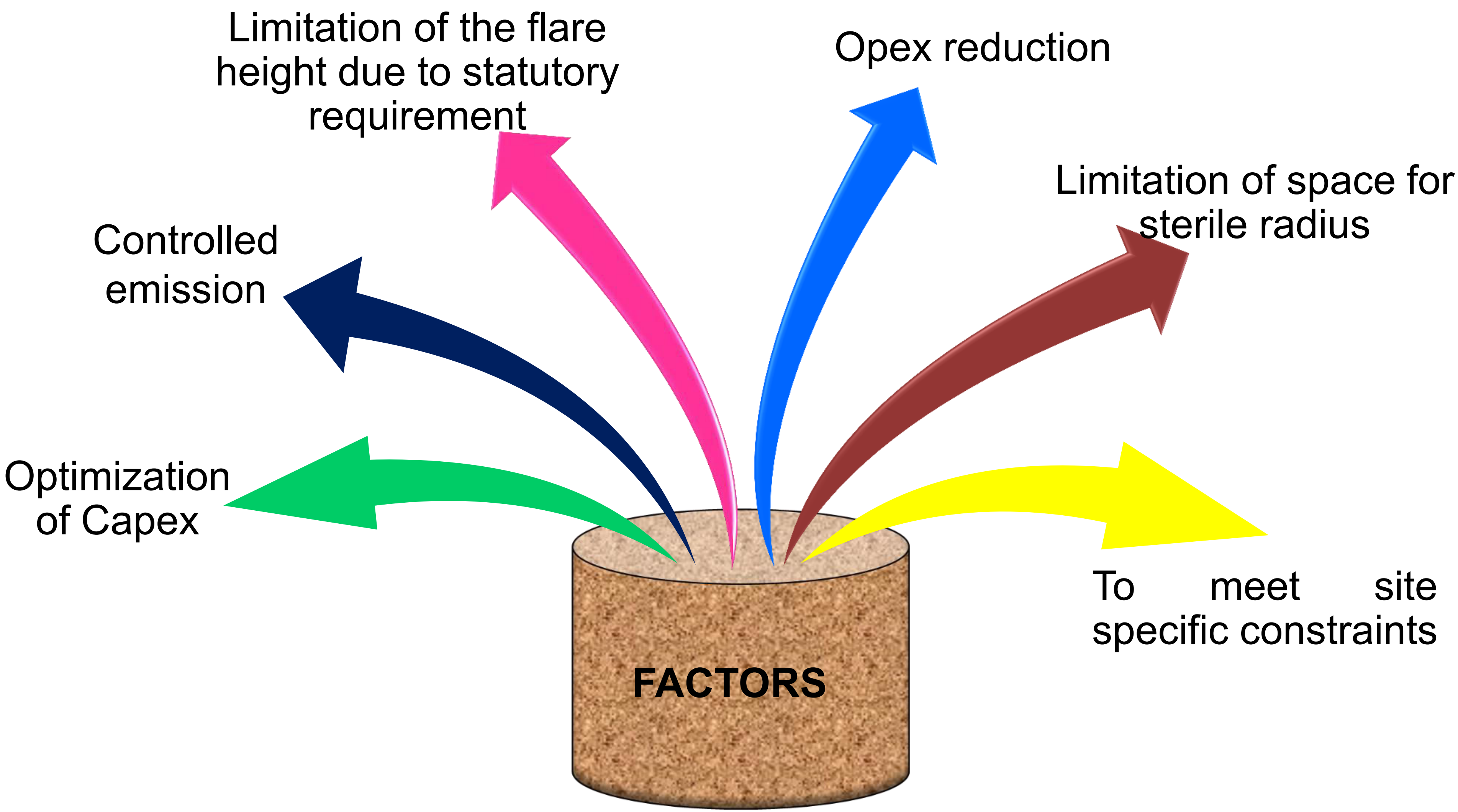
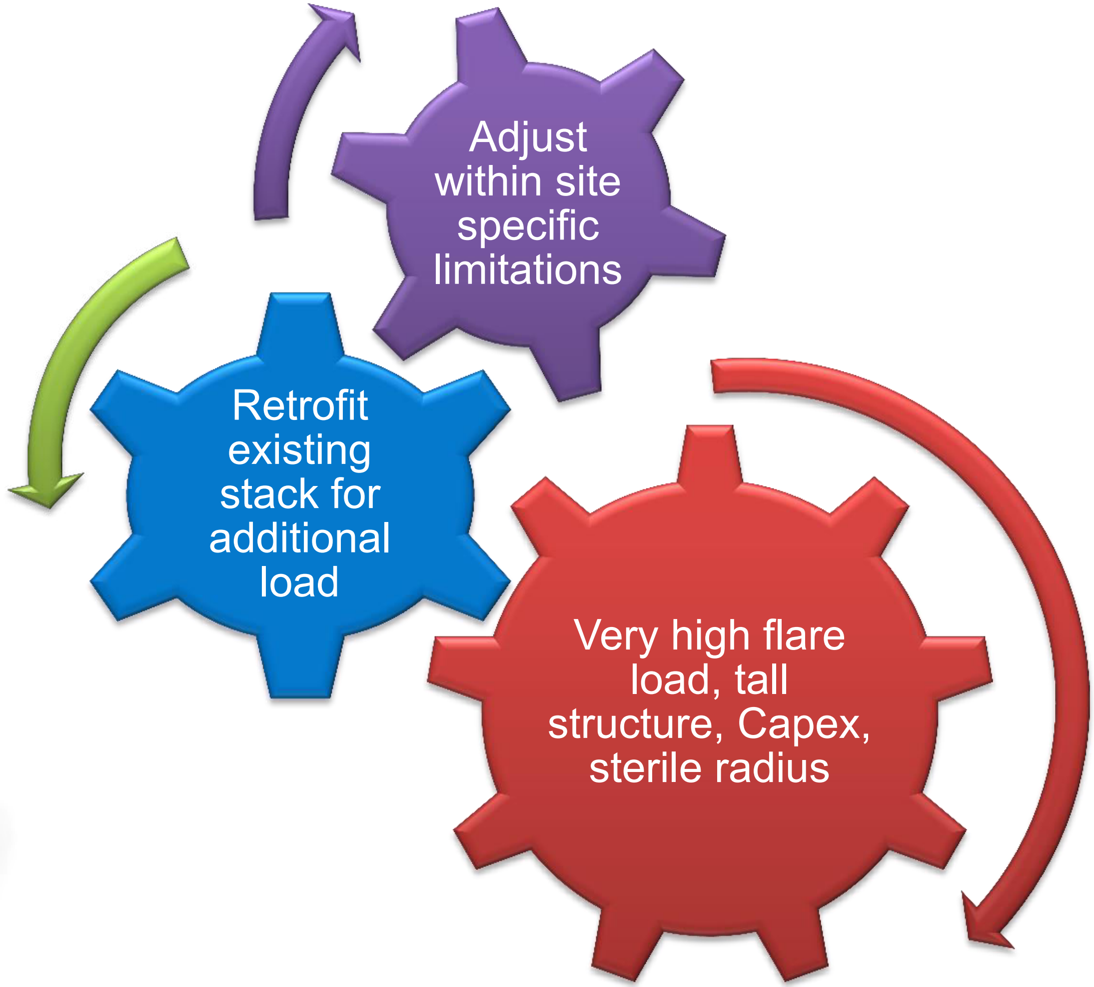
FACTORS LEADING TO MITIGATION EXERCISE



MOST PRESSING ISSUES



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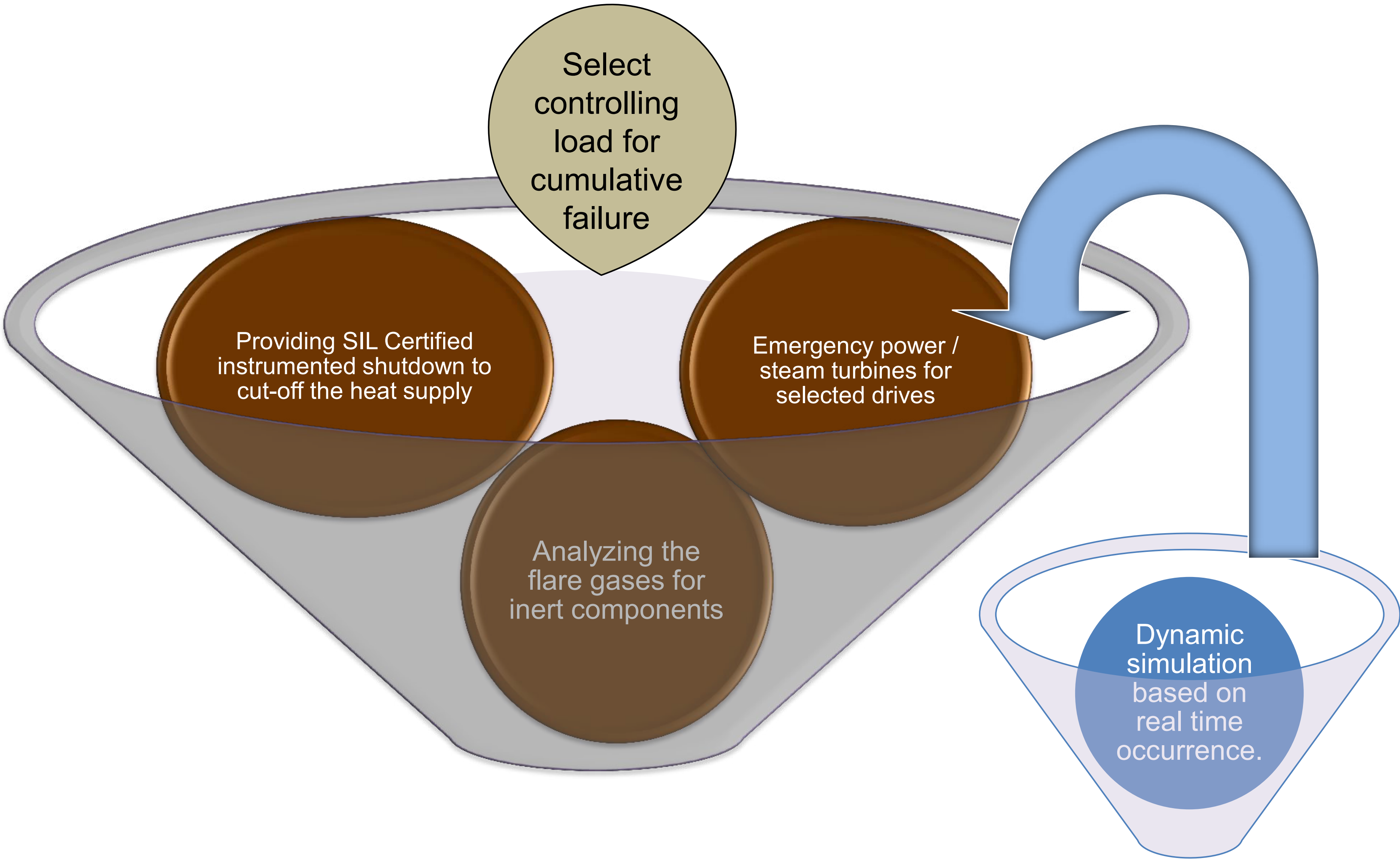
STEPS TO ACHIEVE FINAL GOAL

Basic Design Stage	Detailed design stage	Implementation Issues
• Interact with the Licensor/ Basic Designer • Analyze probable mitigation areas • Provide for additional facilities in case interesting • Check pros and cons before agreeing on mitigation	• Agree for a mitigation philosophy with the owner • Check overall impact of first stage mitigation • Review impact on overall challenge • Review considering additional mitigation measures	• Any additional limitation imposed during execution stage • Constructability issue • Review considering additional mitigation measures

Target: No compromise on safety but minimize the investment of Capital, Construction, Maintenance, Human intervention and Operating expenditure

MEANS OF MITIGATION



DESIGN PHILOSOPHY

Agreement on philosophy amongst Licensor/ Basic Designer, Owner and Flare designer/ PMC is a must

Relief valves: to be sized for unmitigated load for controlling cases

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Individual PSV inlet/outlet lines: to be sized for maximum unmitigated loads

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ISBL header: controlling of max. mitigated load for cumulative failure or max. single unmitigated load

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OSBL Flare system: controlling of max. mitigated load for cumulative failure or max. single unmitigated load

PHILOSOPHY (CONTINUED)

SIL certification needs to be carried out for the associated interlocks analysis

Up-gradation of SIL level reduces possibility of failure and assures reliability

Based on the list of sources contributing towards the total relief load for the complex (e.g. General Power failure and Cooling water failure), decision of up-gradation of SIL level for the individual sources can be decided.

The decision on SIL level calls for additional instrumentation and on line testing.

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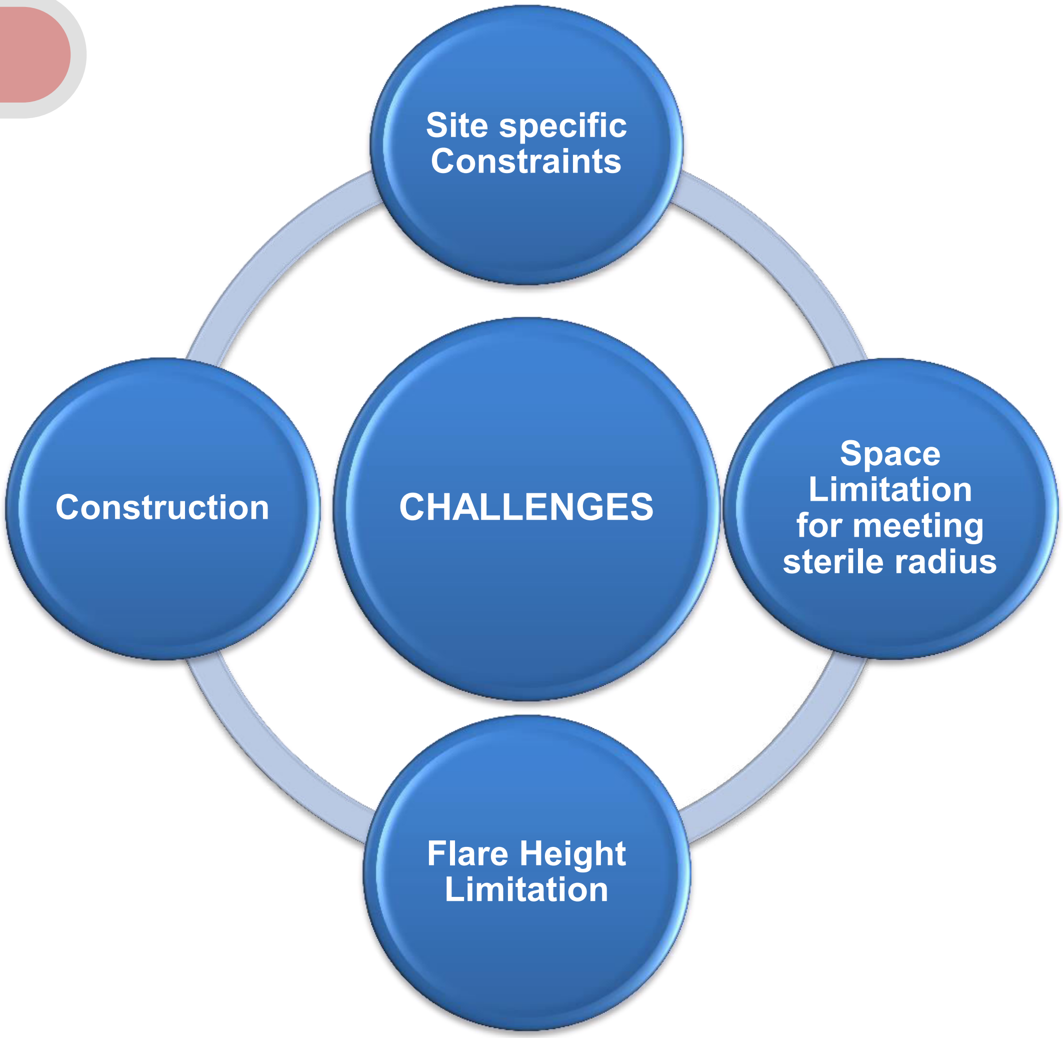
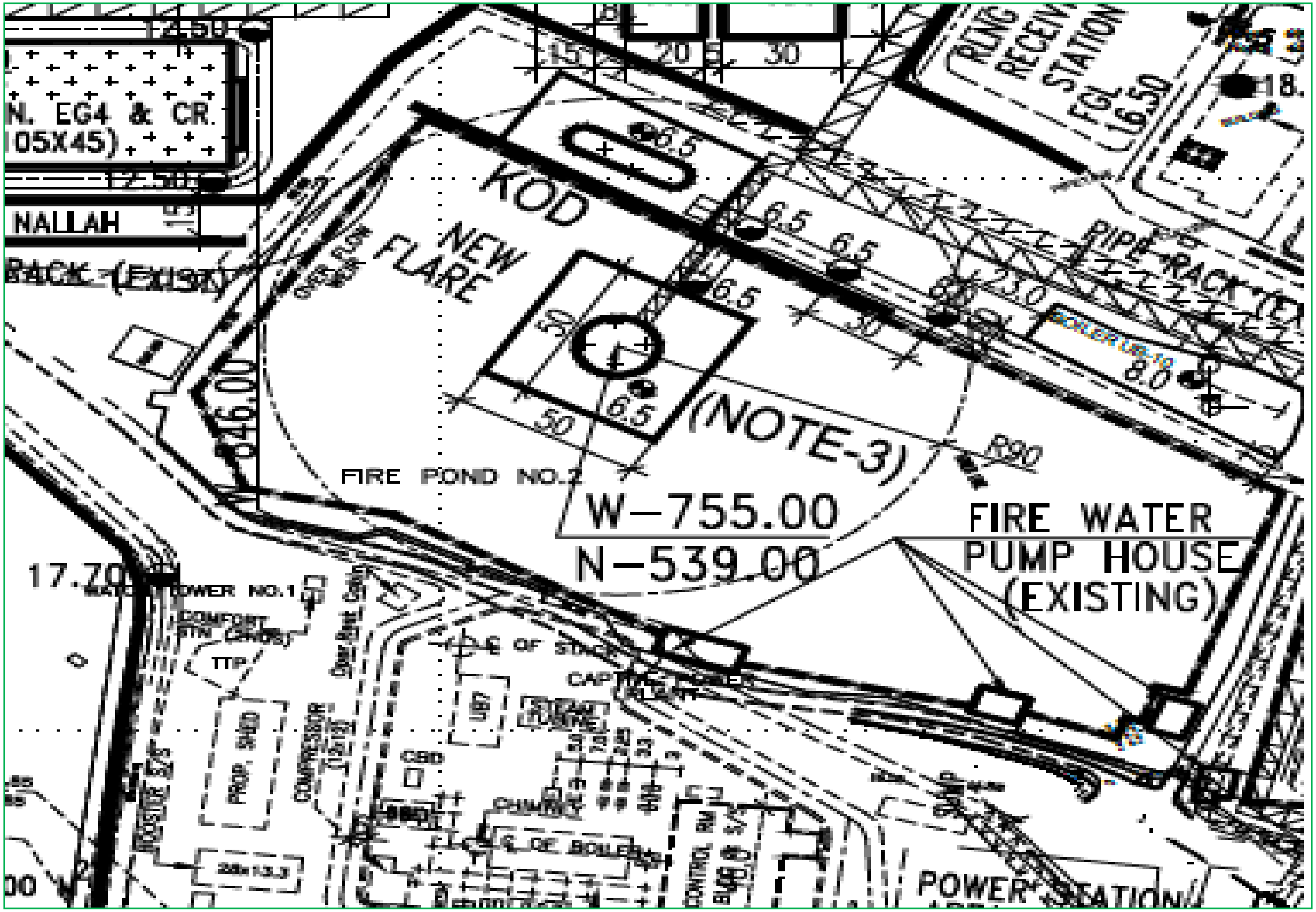
CASE STUDY -1: REFINERY EXPANSION

Major Unit

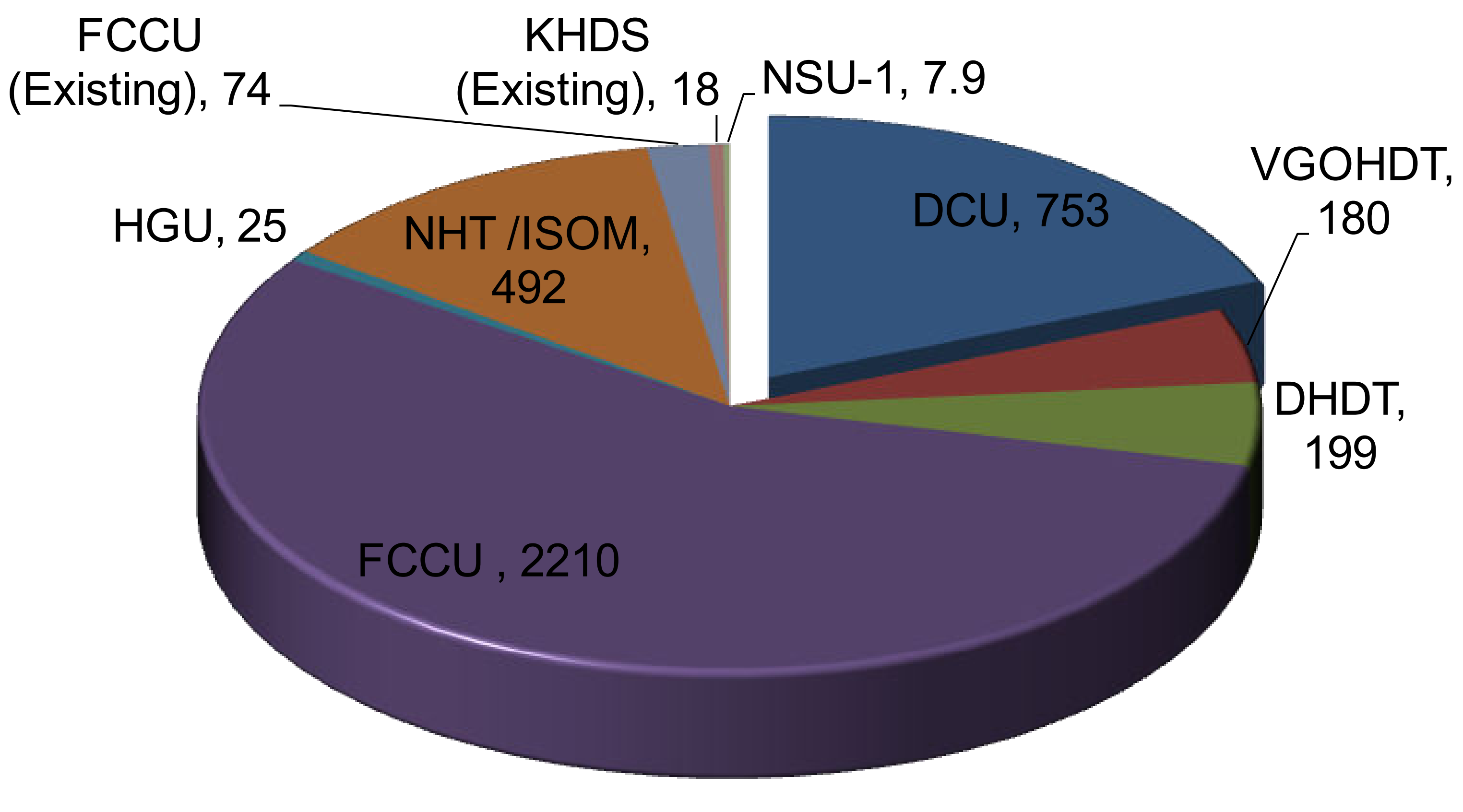
- ❖CDU/VDU
- ❖FCCU
- ❖DHDT
- ❖VGOHDT
- ❖DCU
- ❖Existing FCC
- ❖NHT/ISOM
- ❖CPP and Other Utility Unit



LOCATION OF FLARE STACK



CASE STUDY -1: REFINERY EXPANSION- UNMITIGATED

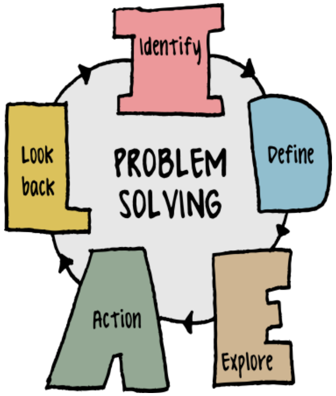


GENERAL POWER FAILURE UNMITIGATED LOADS

CASE STUDY 1: MEANS OF MITIGATION

- Analysis of cumulative failure cases
- Review all heat supply sources
- SIL 3 instrumented shutdown for external heat source
- Analysis of heat source from internal streams
- Situational analysis of feed supply
- Providing emergency utility for specific drives
- Analysis of type of component and their impact on radiation

ASSESS LOAD FOR RADIATION



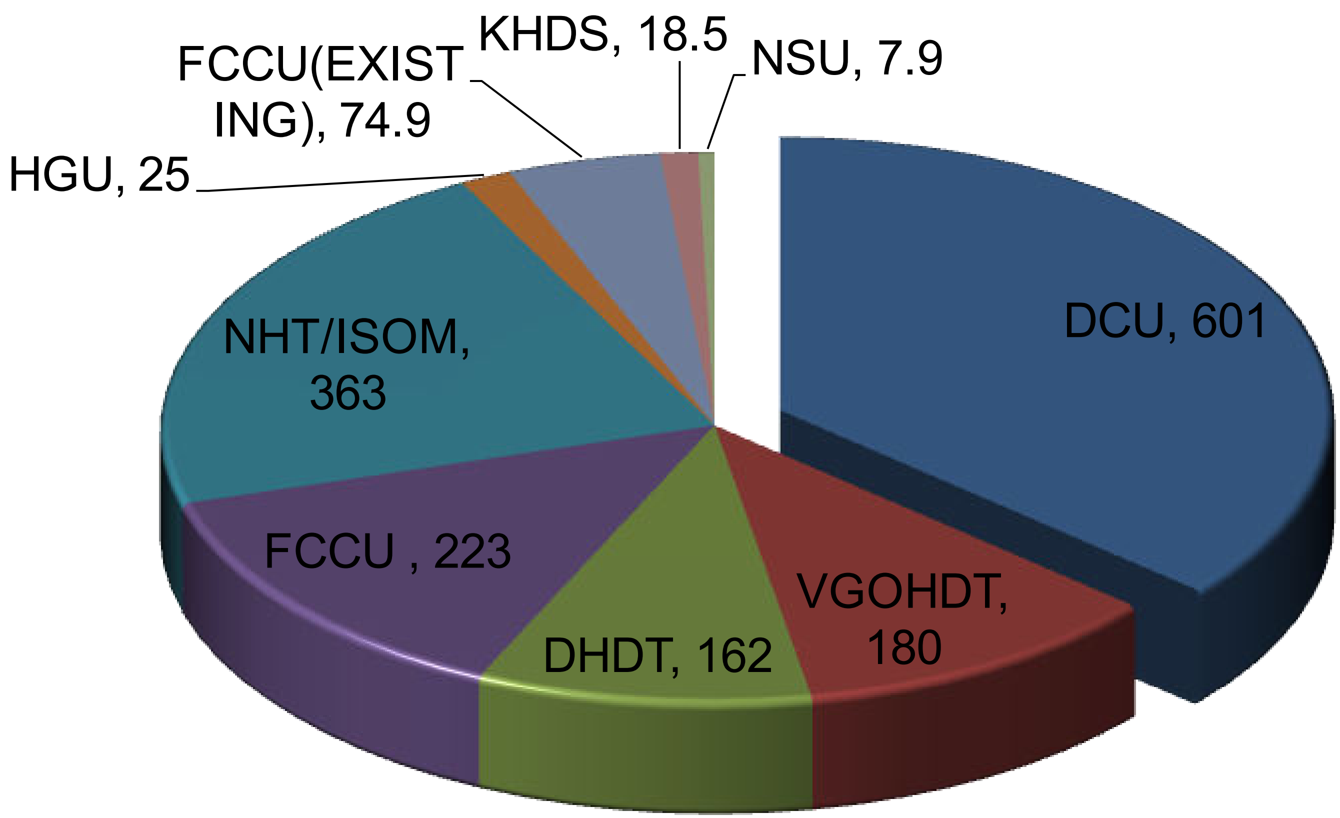
MITIGATION MEASURES & ANALYSIS

Maximum flare load of 3961 t/h, which is expected during total electric power failure

FCC	❖ Provision of steam drive for critical rotating equipment ❖ Shut down of Heater ❖ Advantage of no heating medium due to pump failure ❖ Stoppage of steam supply or Hot water belt supply to reboilers by HI-HI pressure trip of column. ❖ Scenario of feed failure due to pump failure
DCU	❖ Stripping steam cut off at hi-hi pressure in column ❖ Analysis of components and taking advantage in radiation calculation
DHDT	❖ Stripping steam cut off at hi-hi pressure in column ❖ Failure of heater considered ❖ Emergency power supply to few pumps and air cooler motors
NHT/ISOM	❖ Stoppage of steam supply to reboilers by HI-HI pressure trip of column

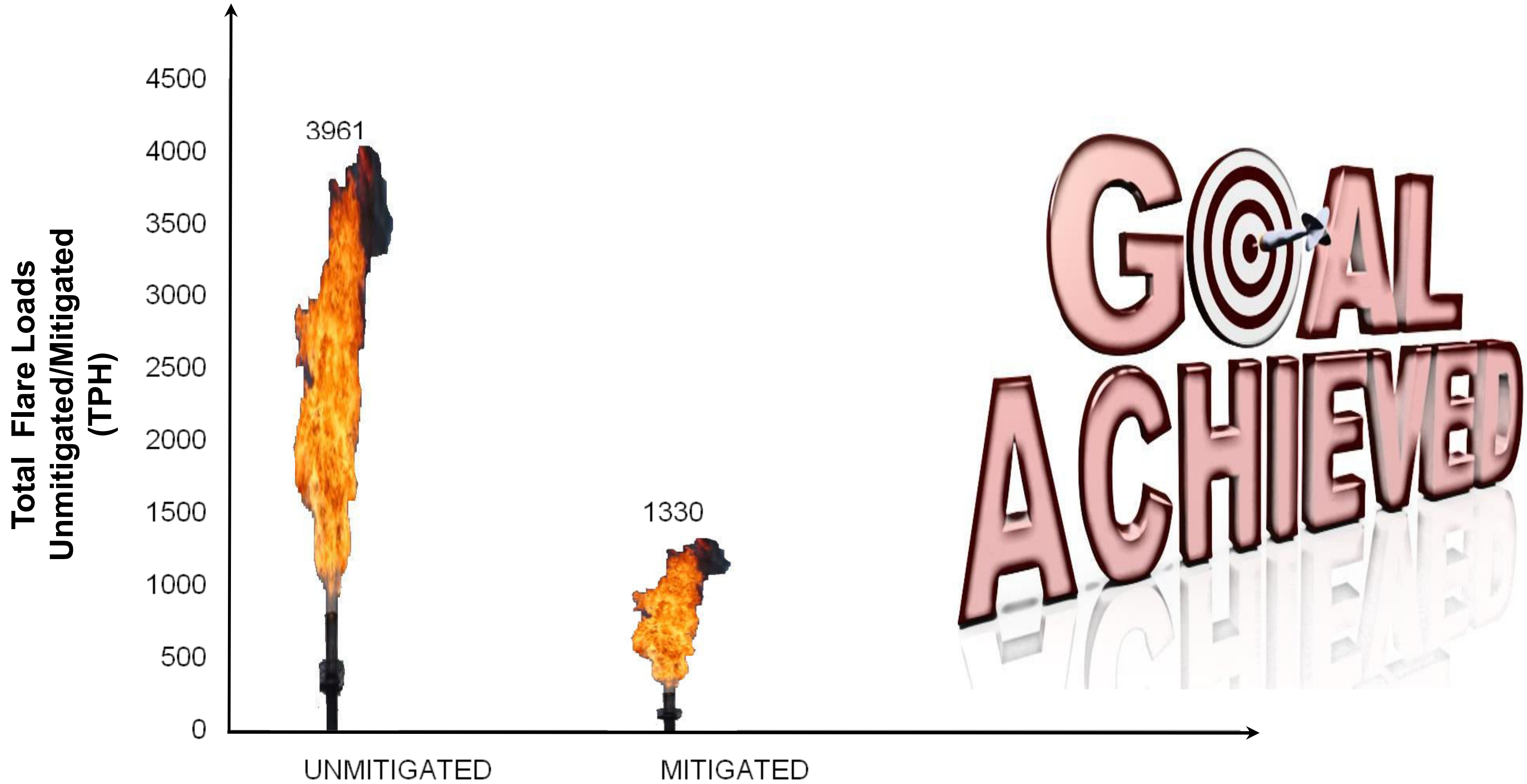
Total flare load after all mitigation measures drops down to 1330 TPH

CASE STUDY -1: REFINERY EXPANSION: MITIGATED



GENERAL POWER FAILURE MITIGATED LOADS

CASE STUDY 1:COMPARISON BETWEEN MITIGATED AND UNMITIGATED LOADS

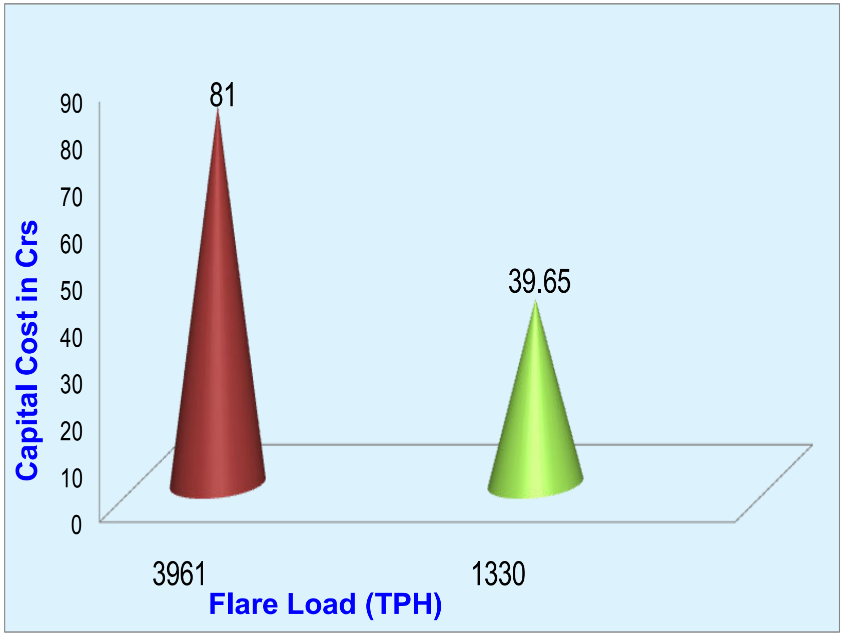


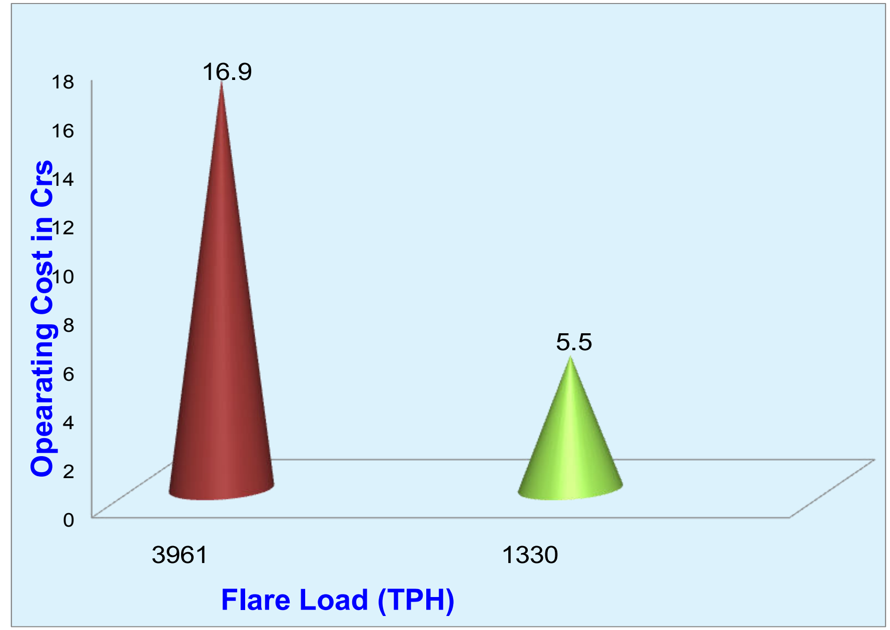
COMPARISON OF GENERAL POWER FAILURE LOADS

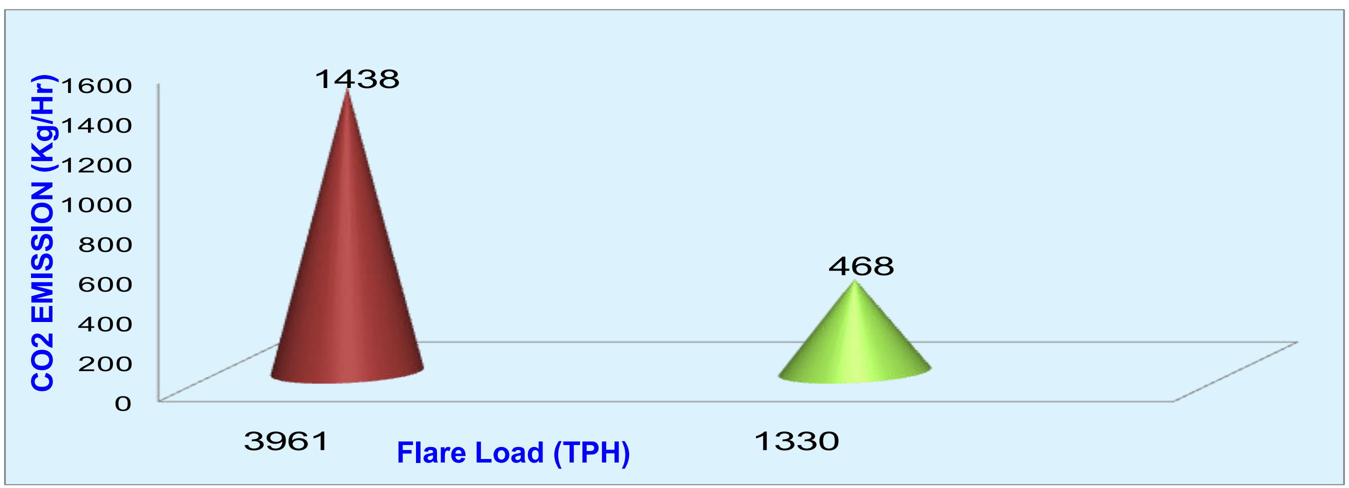
Before Mitigation	
Unmitigated Load	3961 TPH
Stack Dia	100”
Number of Stack	02
Stack Height	280 Meter
Sterile Radius	90 Meter
KOD (2 Nos)	Diameter : 6 Meter Length : 34 Meter

After Mitigation	
Mitigated Load	1330 TPH
Stack Dia	56”
Number of Stack	02
Stack Height	145 Meter
Sterile Radius	90 Meter
KOD(2 Nos)	Diameter : 5 Meter Length : 18 Meter

CASE STUDY -1: BENEFIT







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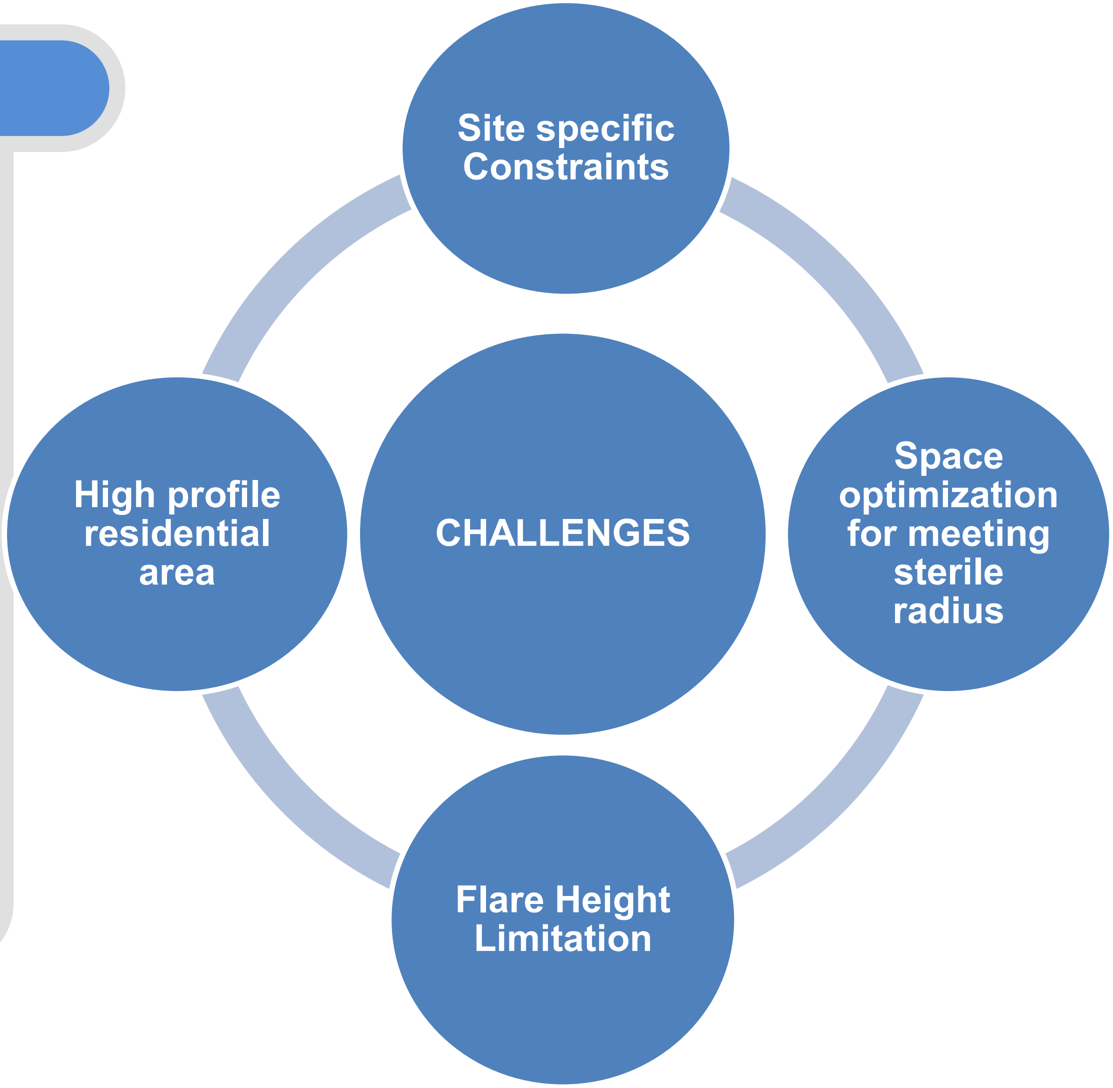
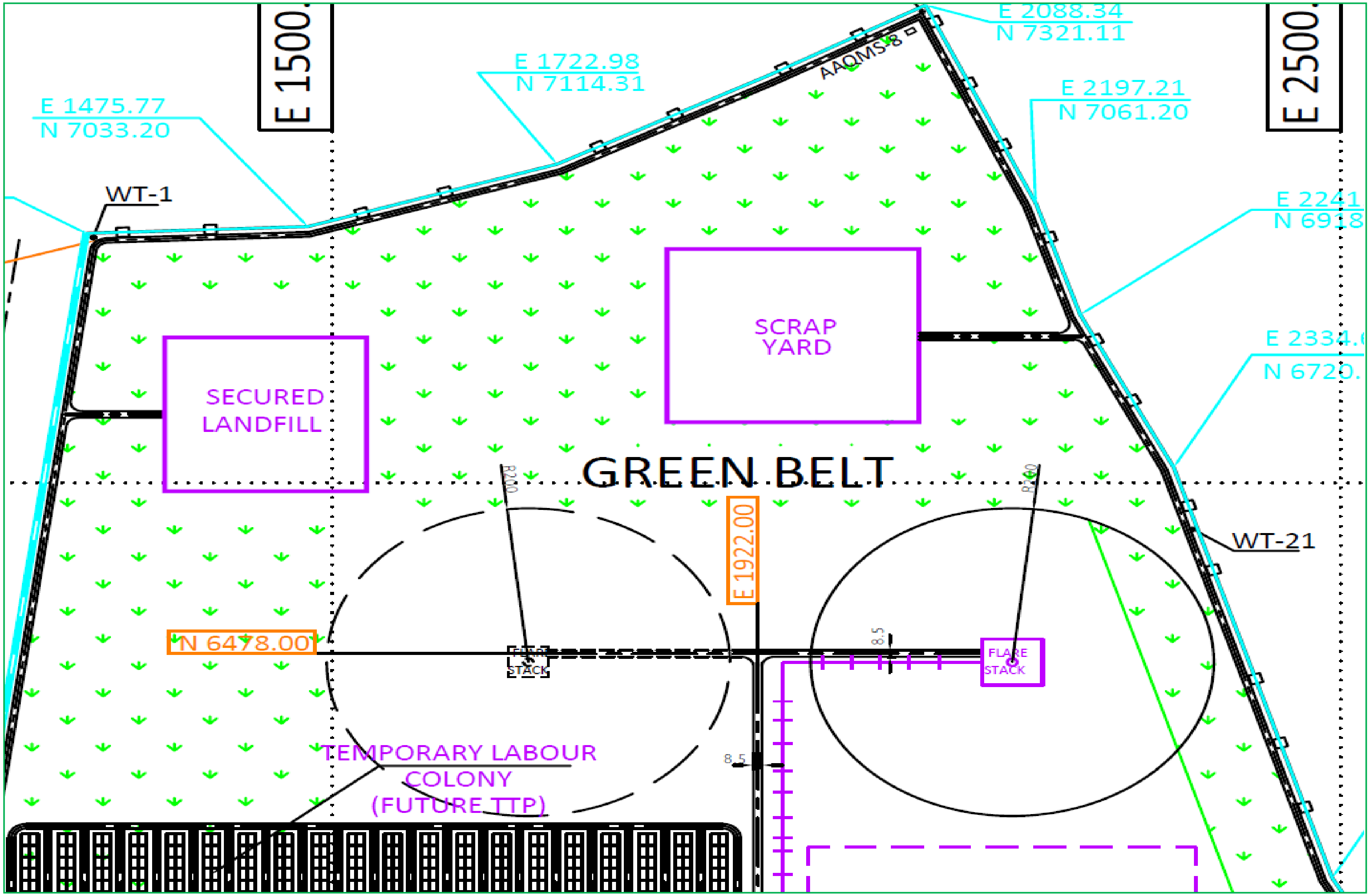
CASE STUDY -2: GRASS ROOT REFINERY

Major Unit

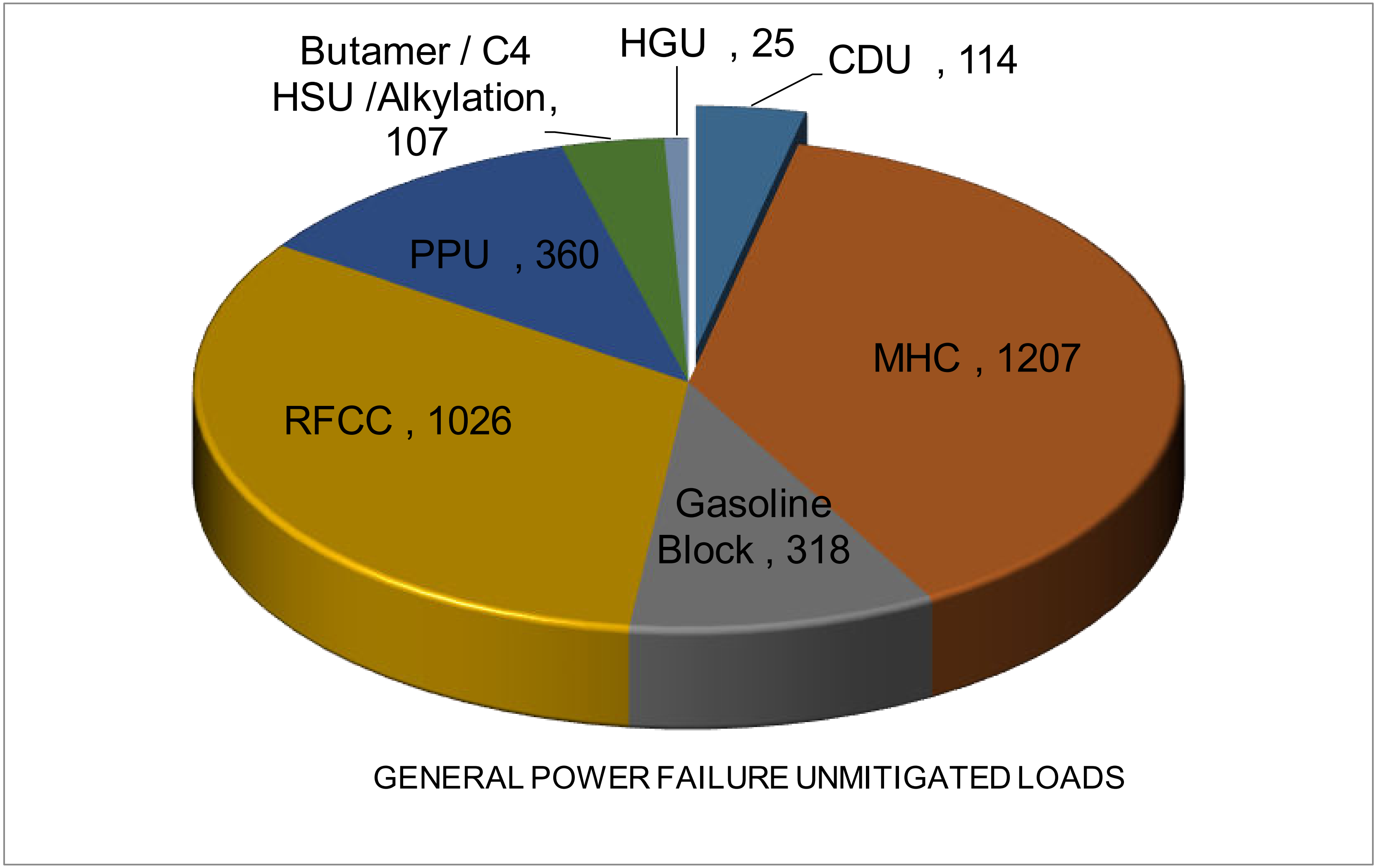
- CDU/VDU
- RFCCU
- MHC
- HGU
- MS-BLOCK
- C4HYD/BUTAMER
- Alkylation
- FCC Gasoline HDS
- Polypropylene
- CPP and Other Utility Unit



LOCATION OF FLARE STACK



CASE STUDY -2: GRASS ROOT REFINERY-UNMITIGATED



CASE STUDY 2: MEANS OF MITIGATION

Analysis of cumulative failure cases

Review all heat supply sources

SIL 3 instrumented shutdown for external heat source

Situational analysis of feed to the equipment

Analysis of type of component and their impact on radiation

Assessment of load for radiation

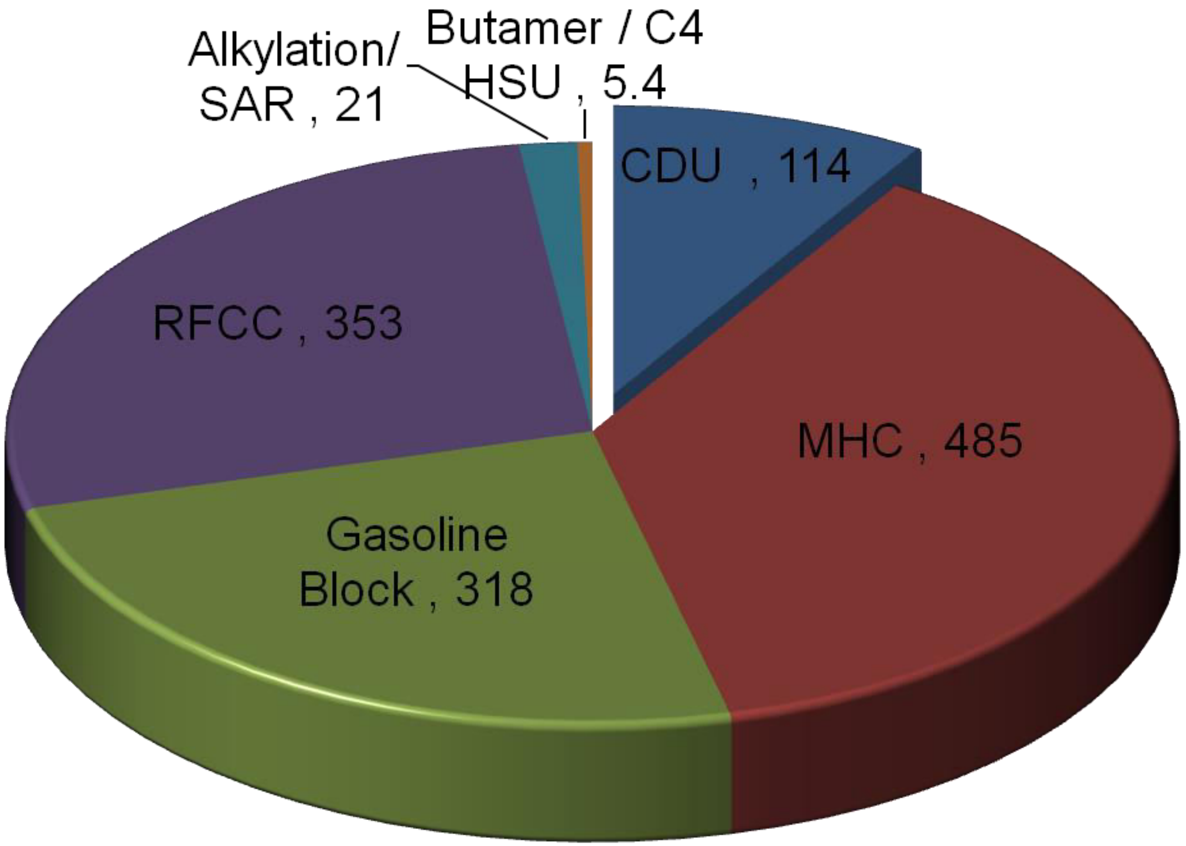
MITIGATION MEASURES & ANALYSIS

Maximum flare load of 3158 t/h, which is expected during total electric power failure

CDU and Sat Gas	❖ Hi-Hi pressure to shut down steam supply to Sat Gas Reboilers ❖ Hi-Hi pressure to shut down steam supply to side Strippers ❖ Analysis of components and taking advantage in radiation calculation
MHC	❖ Hi-Hi pressure to shut down steam supply to side Strippers and column ❖ Natural cooling advantage in the Air cooler design
MS block	❖ Hi-Hi pressure to shut down steam supply to Reboilers ❖ Taking advantage of vacuum design pressure equipment design pressure increase to limit flare load.
RFCC	❖ Hi-Hi pressure to shut down steam supply to reboiler
C4H/BUTAMER	❖ Hi-Hi pressure to shut down steam supply to reboiler

Total flare load after all mitigation measures drops down to 2103 TPH

CASE STUDY -2: GRASS ROOT REFINERY-MITIGATED

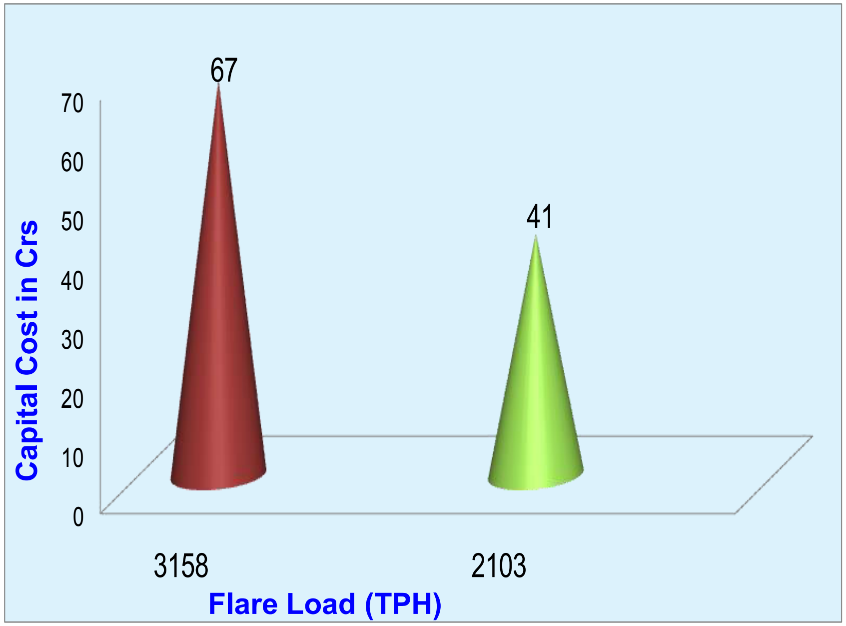


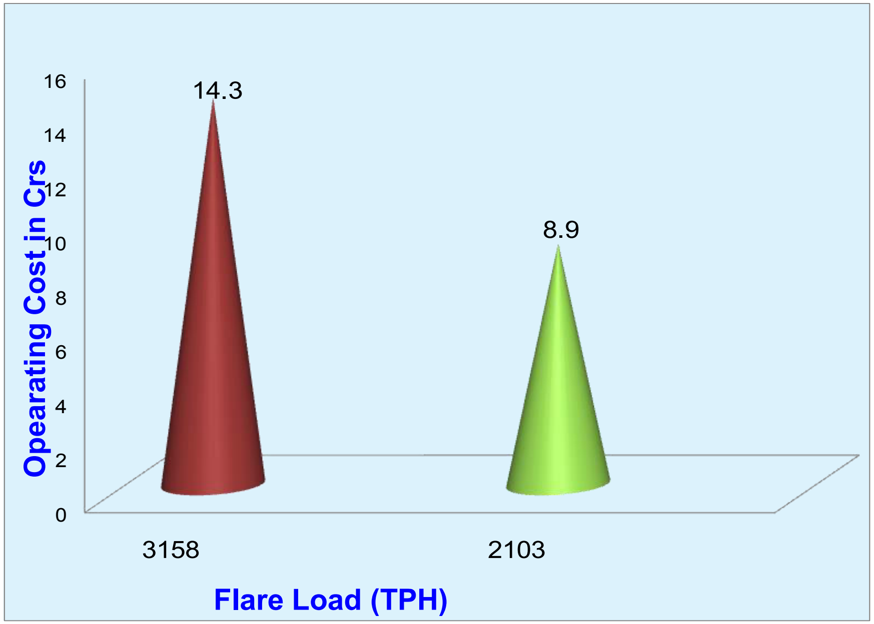
GENERAL POWER FAILURE MITIGATED LOADS

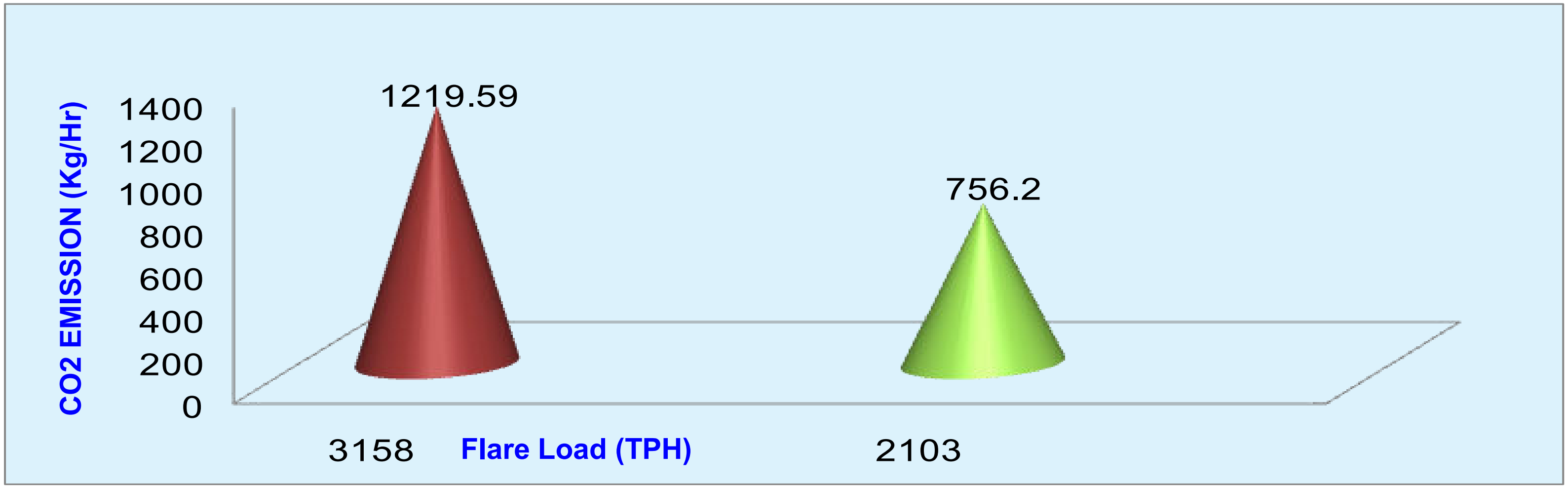
COMPARISON OF GENERAL POWER FAILURE LOADS

Before Mitigation	After Mitigation
Unmitigated Load : 3158 TPH	Mitigated Load : 2103 TPH
Stack Dia : 92”	Stack Dia : 72”
Number of Stack : 02	Number of Stack : 02
Stack Height : 215 Meter	Stack Height : 145 Meter
Sterile Radius : 230 Meter	Sterile Radius : 230 Meter
KOD : Diameter :6 Meter Length : 32 Meter	KOD : Diameter :5 Meter Length : 32 Meter

CASE STUDY -2: BENEFIT







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CASE STUDY -3: OLEFIN COMPLEX

Major Unit

- ❖Ethylene Cracker
- ❖PGHU
- ❖BdEU
- ❖BzEU

Dynamic simulation Carried out by Licensor With detailed design input

CHALLENGES

- **Space optimization for meeting sterile radius**
- **Flare Height Limitation**
- **Capex optimization**

MITIGATION MEASURES & ANALYSIS

Total load ~2000 TPH, normally assessed

Dynamic Simulation to assess cumulative load at real time

Maximum flare load of ~1600 t/h, based on real time analysis which is expected after a specific time interval after the total electric power failure

Further reduction: by shutting down some sources, which relieve within the same time interval

HI- HI pressure shut down of no. of reboilers in Separation section

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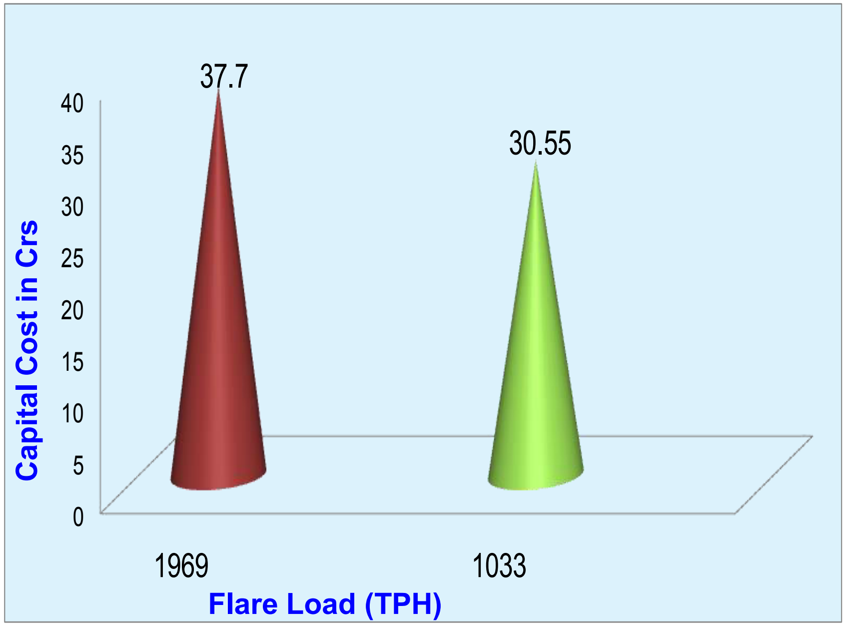
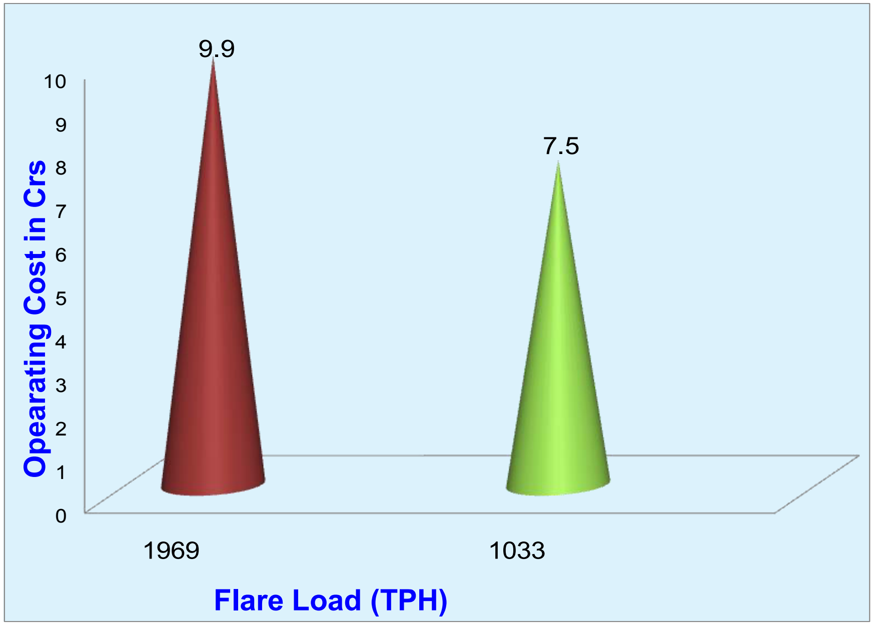
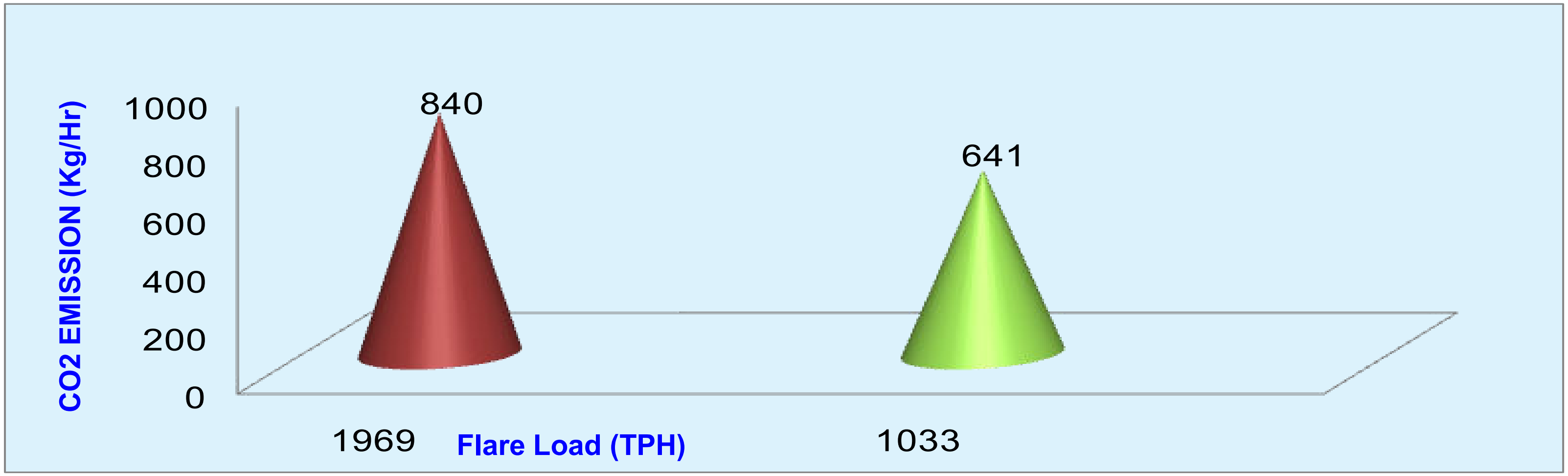
CASE STUDY -3: BENEFIT







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SUMMARIZING

With large scale complex and challenge of space availability flare load mitigation exercise is highly recommended even in the grassroot design

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The benefits of lower flare header size and lower stack diameter and height need to be considered as part of value engineering exercise

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With specific constraints for some complexes, it may be necessary to go for a dynamic simulation

↓

For capacity augmentation or product upgradation projects, addition flare provision is always an issue. Refineries may consider mitigation as a strategy

THANK YOU

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SAFETY AND AVAILABILITY- SIF & SIL

Safety is paramount but availability is important for production.

Safety Instrumented Function (SIF) is a safety function with specified safety Integrity level which is necessary to achieve functional safety. Every SIF has a SIL assigned to it.

- **SIL is a measure of risk reduction of safety function failure.**
- **In another words, Safety Integrity Level (SIL) is how we measure the probability of failure of a safety function carried out by Safety Instrumented System (SIS).**

QUANTITATIVE REPRESENTATION OF SIL

IEC 61511/ 61508 Defines Four Safety Levels to Measure Risks in Handling Plant and its Components.

SIL	PFDavg	Safety Availability	Risk Reduction
4	0.0001-0.00001	0.9999-0.99999	10000-100000
3	0.001-0.0001	0.999-0.9999	1000-10000
2	0.01-0.001	0.99-0.999	100-1000
1	0.1-0.01	0.9-0.99	10-100

PFD : Probability of Failure on Demand

In process industry SIL 3 is the highest. In Nuclear industry SIL 4 may be required.

INFORMATION ON THE SIL LOOP

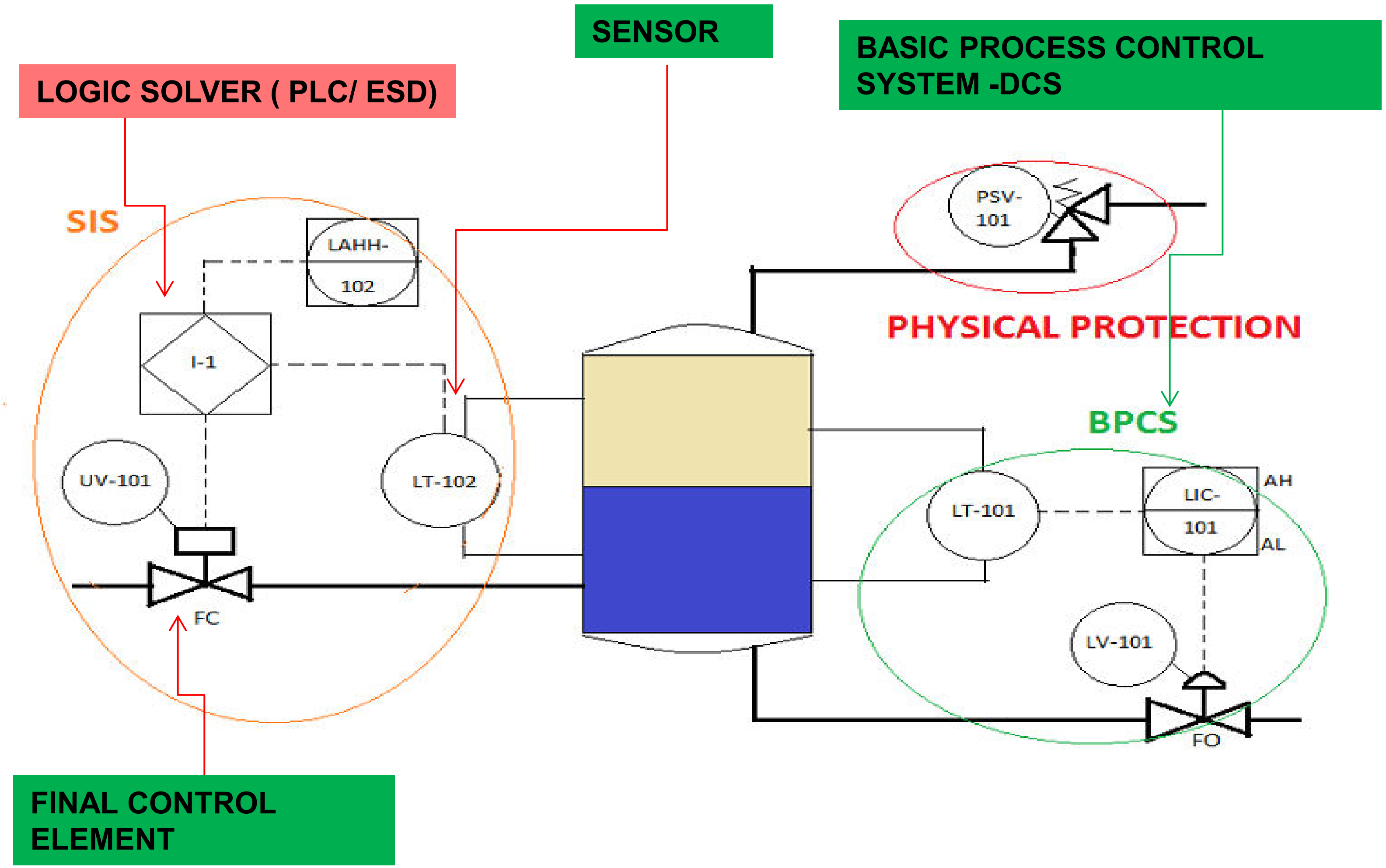
Safety integrity level 4 has the highest level of safety integrity; safety integrity level 1 has the lowest safety integrity.

It is possible to use several lower safety integrity level systems to satisfy the need for a higher level function (for example, using a SIL 2 and a SIL 1 system together to satisfy the need for a SIL 3 function).

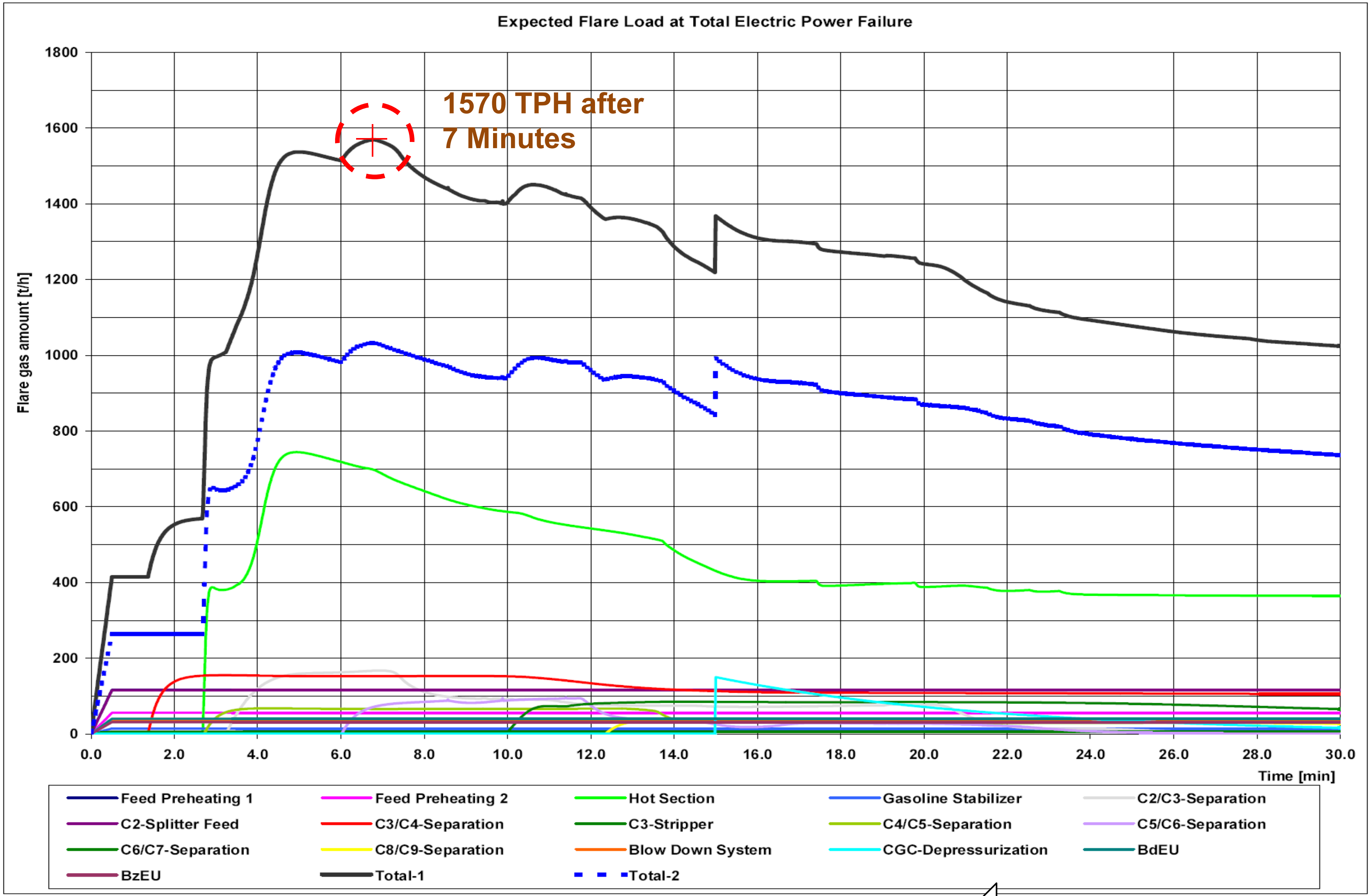
The SIL loop will normally require one or most of the following

- **Addition of sensor elements with appropriate voting**
- **Addition of final control elements with appropriate voting**
- **Providing partial stroke testing on final elements**
- **Reduction of Proof Test Period**

REPRESENTATION OF SIS



CASE STUDY -3: Olefin Complex



RECOMMENDED DESIGN THERMAL RADIATION

Permissible radiation limit btu/hr-ft2	Conditions
500	Public radius. Personnel with appropriate clothing can be exposed
1500	Personnel with appropriate clothing can be exposed for 2-3 minutes (sterile radius)
2000	Personnel with appropriate clothing can be exposed for 30 seconds
3000	Radiation shield special protective apparel for few seconds

Includes solar radiation which can be varied 250-330 btu/ hr-ft2