



SAFETY DURING PROCESS DESIGN

CONTENTS

- INTRODUCTION
- DESIGN CRITERIA
- TYPICAL SYSTEMS
 - REFINERY
 - PIPELINE
 - GAS PROCESSING
 - HIGH PRESSURE SYSTEMS
- CONCLUSION

INTRODUCTION

- PROCESS PLANTS FOLLOW GOOD AND PROVEN DESIGN/ENGINEERING PRACTICE
- BASIC ENGINEERING DESIGN DATA ADDRESSES ISSUES RELATED TO OPERATING PHILOSOPHY AND PRACTICES TO BE ADOPTED.

BASIC ENGINEERING DESIGN DATA

- OVERDESIGN AND SPARING
- DESIGN CRITERIA
- INSTRUMENTATION
- LAYOUT
- UTILITY SYSTEMS
- SPECIAL CUSTOMER REQUIREMENTS

DESIGN CRITERIA --TEMPERATURE

- DESIGN TEMPERATURE— MARGIN OF 15-20 DEG C OVER MAXIMUM OPERATING TEMPERATURE
- CONSIDER ISSUES LIKE DEPRESSURIZATION, STEAM OUT, BYPASS OF SPECIFIC EQUIPMENT WHILE FIXING DESIGN TEMPERATURE

DESIGN CRITERIA--PRESSURE

- FACTORS TO BE CONSIDERED
 - ✓ PUMP SHUT OFF
 - ✓ RANGE OF OPERATING PRESSURE
 - ✓ SYSTEM HYDRAULICS
 - ✓ TEMPERATURE

INSTRUMENTATION

- REDUNDANCY
- PHILOSOPHY OF ALARMS AND TRIPS
- SAFETY VALVE NOS, TYPE
- EMERGENCY DEPRESSURIZATION
- VOTING SYSTEMS

TYPICAL HIGH PRESSURE SYSTEMS

- REFINERY PROCESSES- CRUDE FEED CIRCUITS
- HYDROTREATING/HYDROCRACKING UNITS
- GAS SWEETENING/PROCESSING UNITS
- PIPELINES

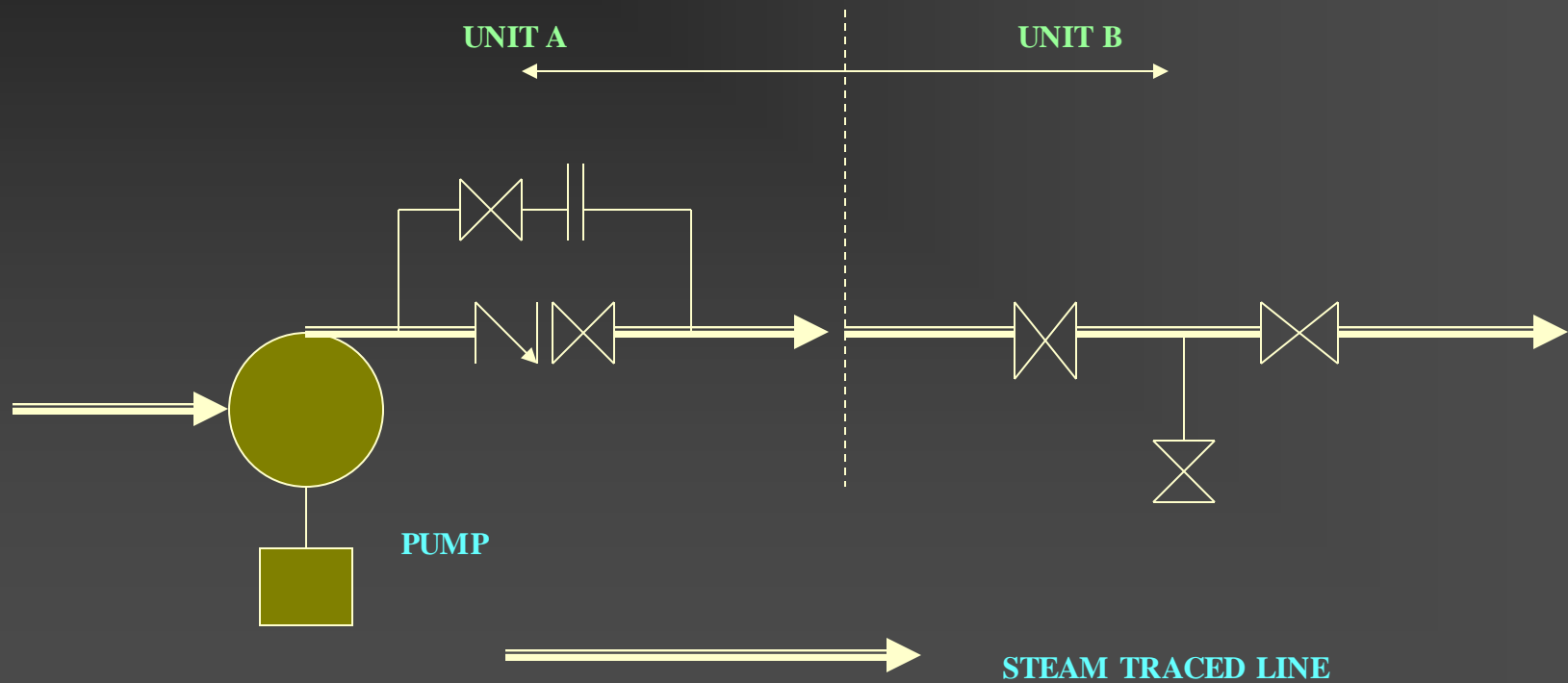
HAZARD MANAGEMENT PHILOSOPHY

- IDENTIFY SAFETY HAZARD AT DESIGN STAGE
- SELECT STRATEGY AND OPTIMIZE DESIGN
- PROVIDE SYSTEMS TO CONTROL HAZARDS

CONTROL MEASURES

- USE APPROPRIATE CODES AND STANDARDS
- MINIMIZE INVENTORY
- OPTIMIZE RELEASE LOCATIONS
- PLANT LAYOUT

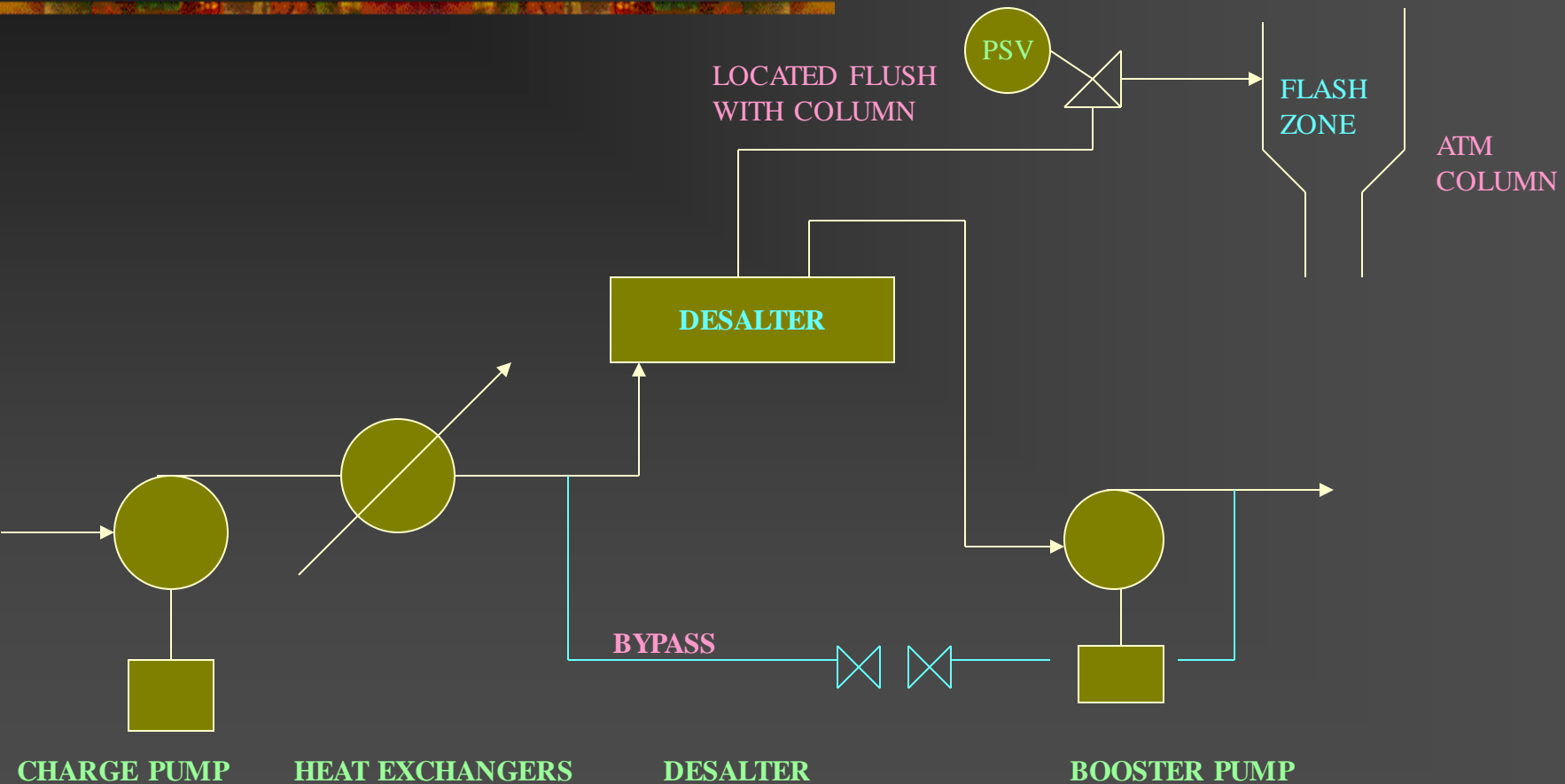
BLOCKED IN LIQUID



OPERATIONAL CONSTRAINTS

- STEAM TRACING NOT TO BE KEPT ON IF LINE IS ISOLATED AT BOTH ENDS
- LINE IS DESIGNED FOR PUMP SHUT OFF PRESSURE –NOT ADEQUATE FOR LIQUID EXPANSION
- FOLLOW OPERATING PROCEDURES

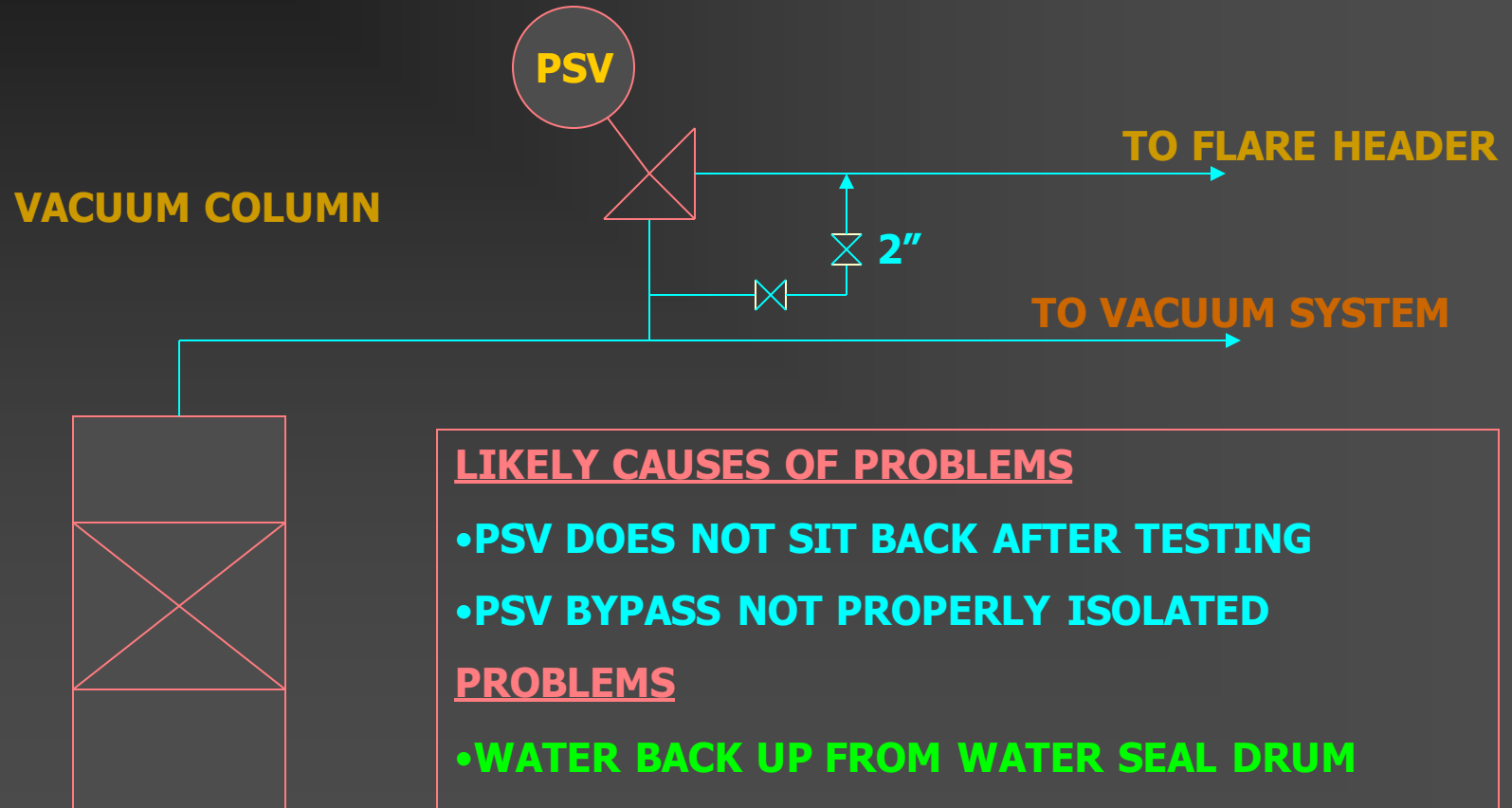
CRUDE FEED CIRCUIT-PREHEAT AND DESALTER



DESALTER ARRANGEMENT- LIMITATIONS

- DESALTER NOT DESIGNED FOR PUMP SHUT OFF PRESSURE-COST CONSIDERATIONS
- USE BYPASS LINE BEFORE COMMISSIONING DESALTER TO AVOID SHUT OFF CONDITION
- START CORROSION INHIBITOR AND CHEMICAL DOZING FACILITIES TO AVOID CORROSION

PSV AS A POTENTIAL HAZARD SOURCE



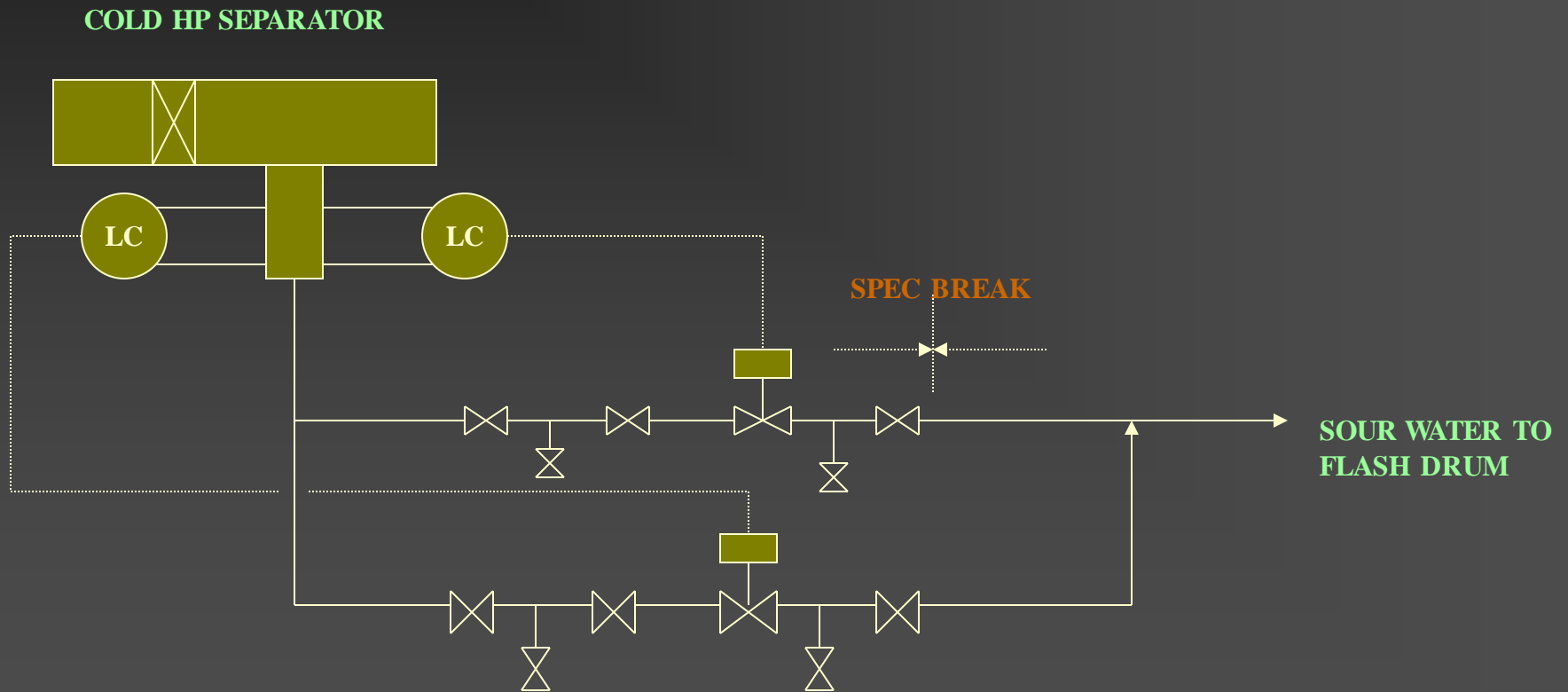
LIKELY CAUSES OF PROBLEMS

- **PSV DOES NOT SIT BACK AFTER TESTING**
- **PSV BYPASS NOT PROPERLY ISOLATED**

PROBLEMS

- **WATER BACK UP FROM WATER SEAL DRUM**
- **VACUUM PULL IN FLARE HEADER**
- **VIBRATIONS AND DAMAGE TO FLARE HEADER**

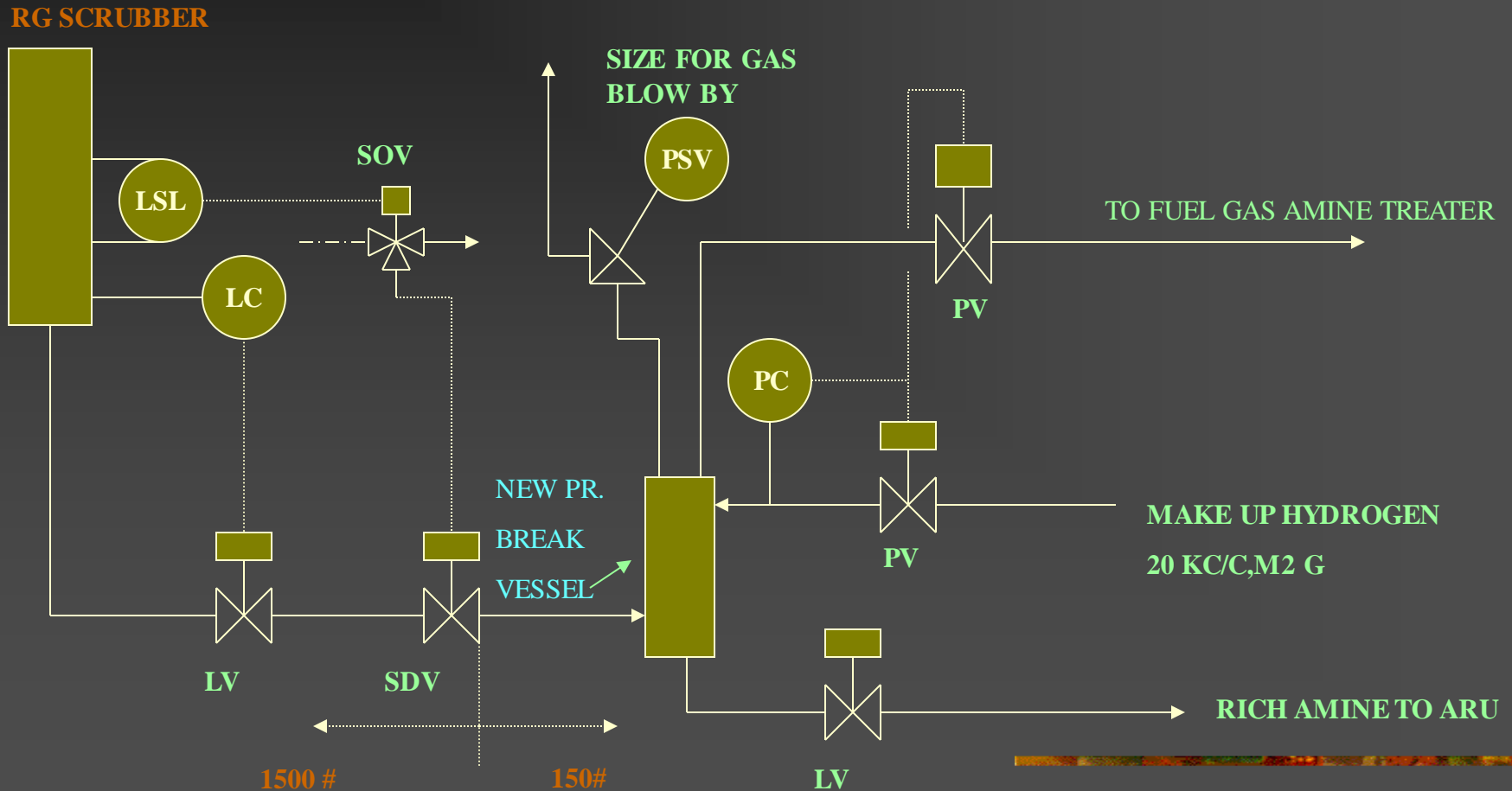
HP-LP LET DOWN ARRANGEMENT



LIKELY CONSTRAINTS

- UPSTREAM FACILITIES ARE RATED FOR HIGH PRESSURE (1500#)
 - FACILITIES DOWNSTREAM OF LV ARE DESIGNED FOR LOW PRESSURE(150#)
 - NO PROVISION FOR LV GOING FLAT OPEN
 - PROVIDE PSV TO ACCOUNT FOR LV FAILURE
 - PROVIDE FACILITY TO BREAK THE PRESSURE
 - PROVIDE HIPPS FACILITY
-

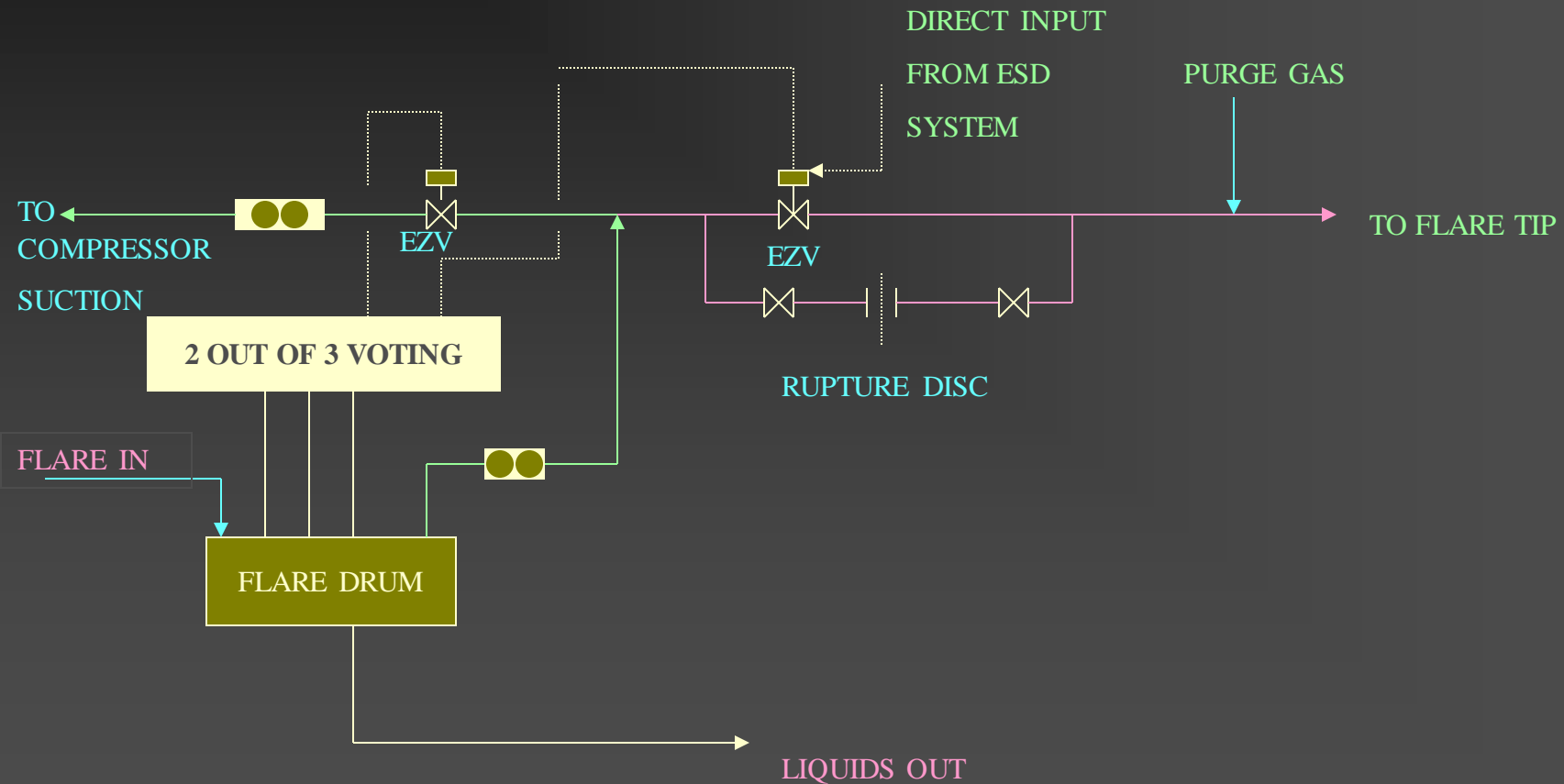
HP-LP LETDOWN ARRANGEMENT



HIGH INTEGRITY PRESSURE PROTECTION SYSTEMS -HIPPS

- SHOULD HAVE THE SAME OR BETTER RELIABILITY AS COMPARED TO PRESSURE RELIEVING DEVICES
- COMPLIANCE WITH DIN 3381
- QUICK CLOSING VALVES(<2 SECONDS)
- IN SOME CASES SYSTEM DYNAMICS MAY JUSTIFY HIGHER CLOSING TIMES
- DEDICATED INSTRUMENTATION
- LOCAL RESET
- FAIL CLOSE FOR LOSS OF INST AIR, HYDRAULIC OR ELECTRIC POWER

HIPPS CONFIGURATION –FLARE SYSTEM



GAS PROCESSING FACILITIES

- GAS SWEETENING
- C2/C3 RECOVERY
- LPG RECOVERY

PLANT DESIGNS TAKE CARE OF MAXIMUM TEMPERATURE, PRESSURE REQUIREMENT AND COMPOSITION CHANGES

CHANGES IN WELL PRESSURES , WELL CONFIGURATION ETC COULD PUSH THE OPERATION TO DESIGN LIMITS

GAS-OIL SEPARATION

- OPERATE FOR SPECIFIED GOR
- HOOKING UP NEW WELLS CAN LEAD TO LIMITATIONS IN THE GAS DISPOSAL SYSTEM
- REDUCE TIME FOR OPERATOR'S RESPONSE

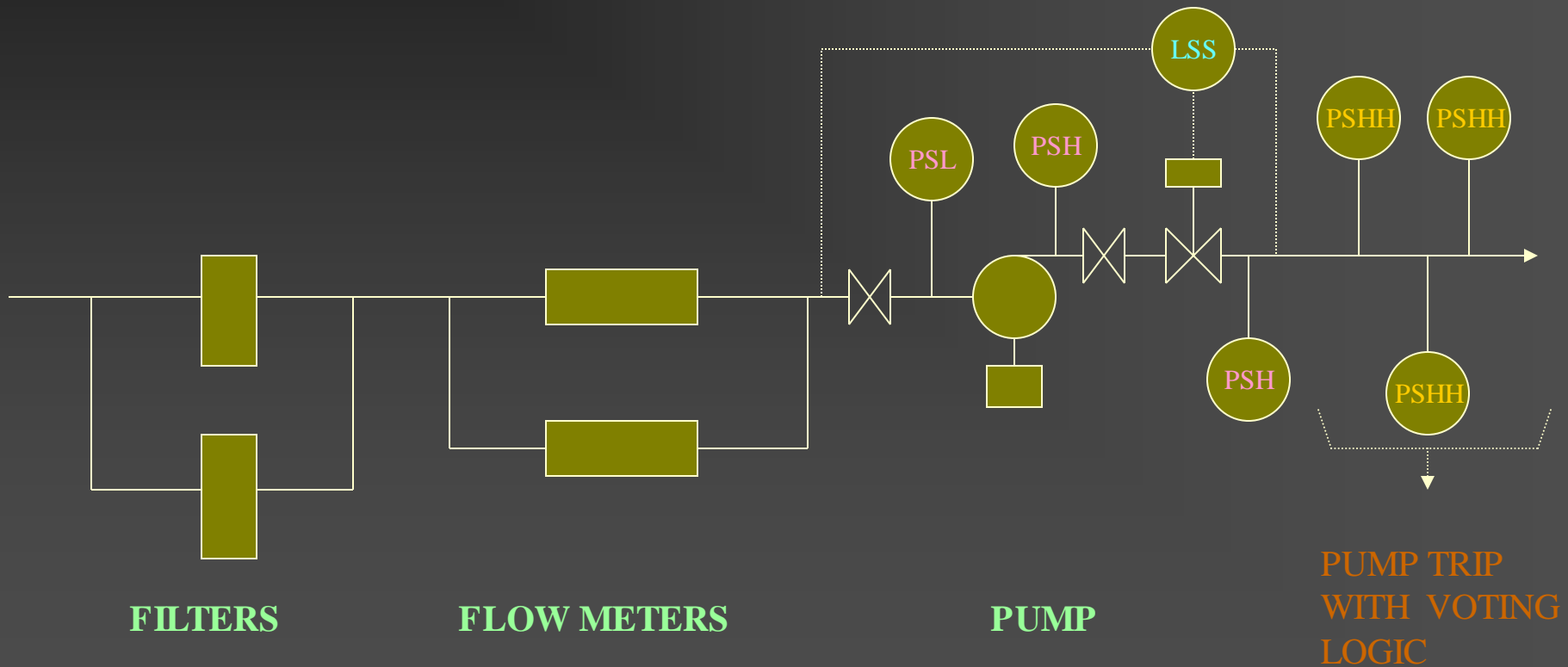
GAS PROCESSING UNITS

- FLOW SCHEME CONFIGURATION IS IMPORTANT
- PLATE FIN EXCHANGERS NEED TO BE LOCATED DOWNSTREAM OF DRYERS- OTHERWISE CHOKING, LOSS OF T'PUT AND PRESSURE BUILD UP CAN OCCUR
- HYDRATE AND ICE FORMATION NEED TO BE CAREFULLY MONITORED

GAS PROCESSING UNITS

- FEED GAS COMPOSITION IMPACT
REQUIRES PROPER UNDERSTANDING
- LEAN GAS → LOWER PLANT TEMPERATURES
- HEAVY GAS → MORE LIQUIDS GENERATION
- MOLECULAR WEIGHT VARIATION
→ VARIATION IN C/F COMPRESSOR
PERFORMANCE—OPERATION NEAR
SURGE CONDITION IN SOME CASES

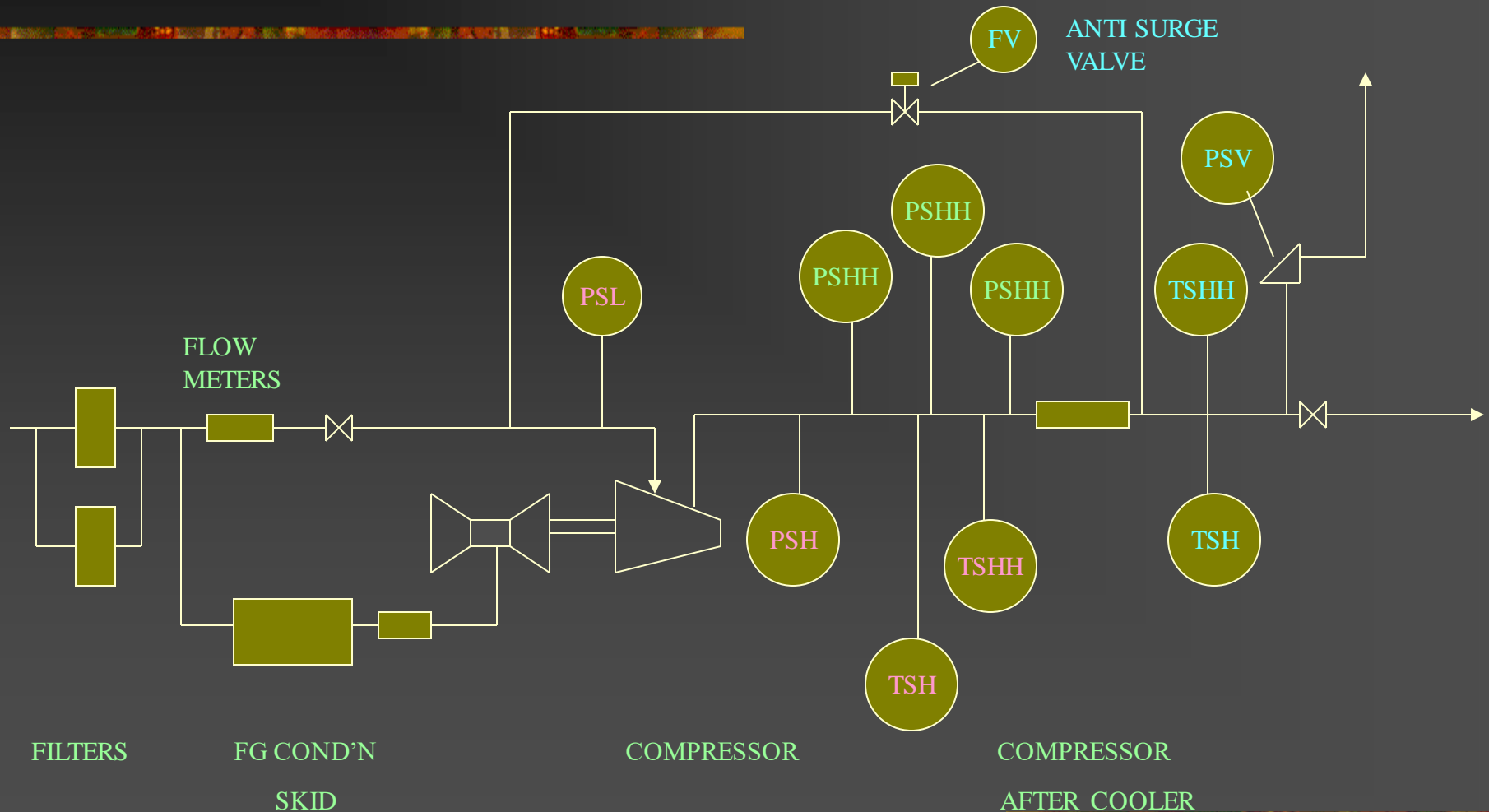
LIQUID PIPELINE PUMP STATION



LIQUID PIPELINE SYSTEM CONTROLS

- PRESSURE CONTROL VALVE D/S OF PUMPS
 - HIGH PRESSURE PRE ALARM D/S OF PCV
 - PSHH TRIP WITH VOTING SYSTEM
 - LOW AND HIGH PR SWITCH AT PUMP SUCTION AND DISCHARGE
 - CLOSING COMMAND FOR REMOTE OPERATED/ SECTIONALIZING VALVE TO TRIP THE PUMP TO AVOID SURGE DURING PIPELINE OPERATION
-

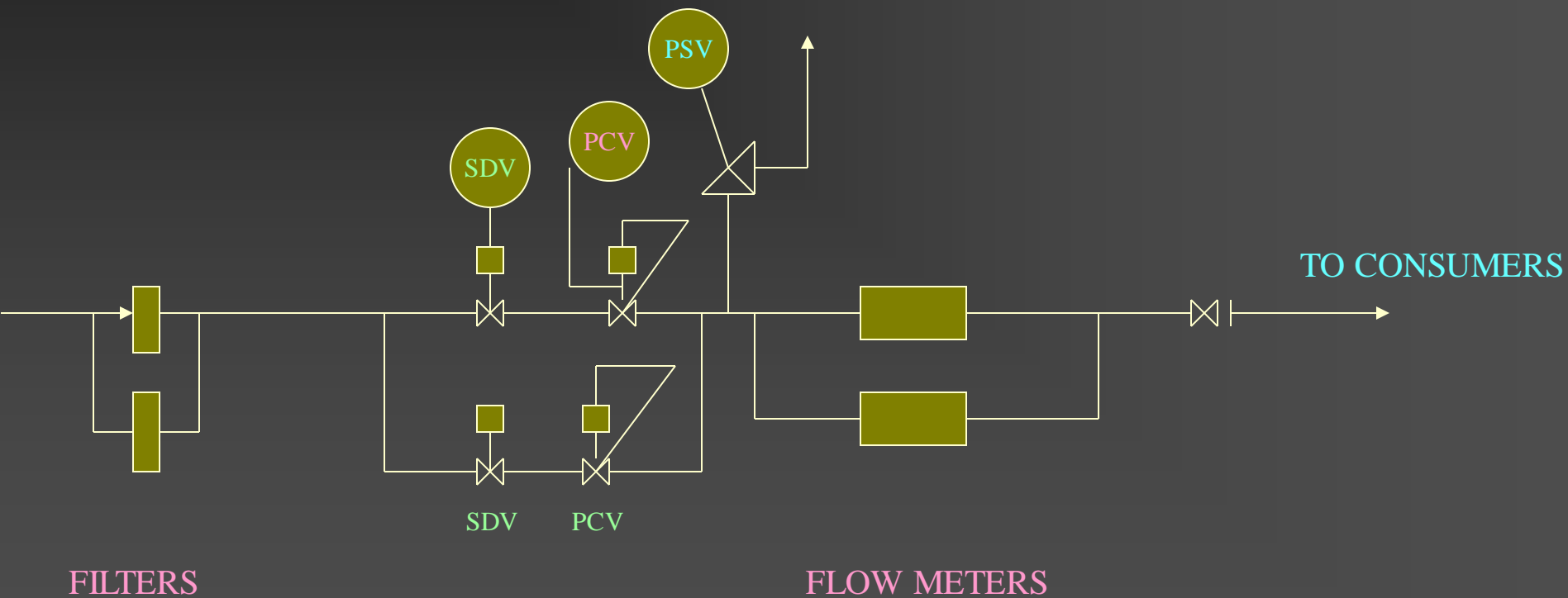
GAS PIPELINE-COMPRESSOR STATION



GAS PIPELINE-SYSTEM CONTROLS

- PSV DOWNSTREAM OF EACH COMPRESSOR
- ANTI SURGE PROTECTION
- HIGH/ HIGH HIGH PRESSURE AND TEMPERATURE SWITCHES AT DISCHARGE OF COMPRESSORS
- PRESSURE REDUCTION SYSTEM WITH STAGGERED SET POINTS AT RECEIPT TERMINAL OR FLOW CONTROL SYSTEM
- SHUT DOWN VALVES AND PSV'S AT RECEIPT TERMINALS

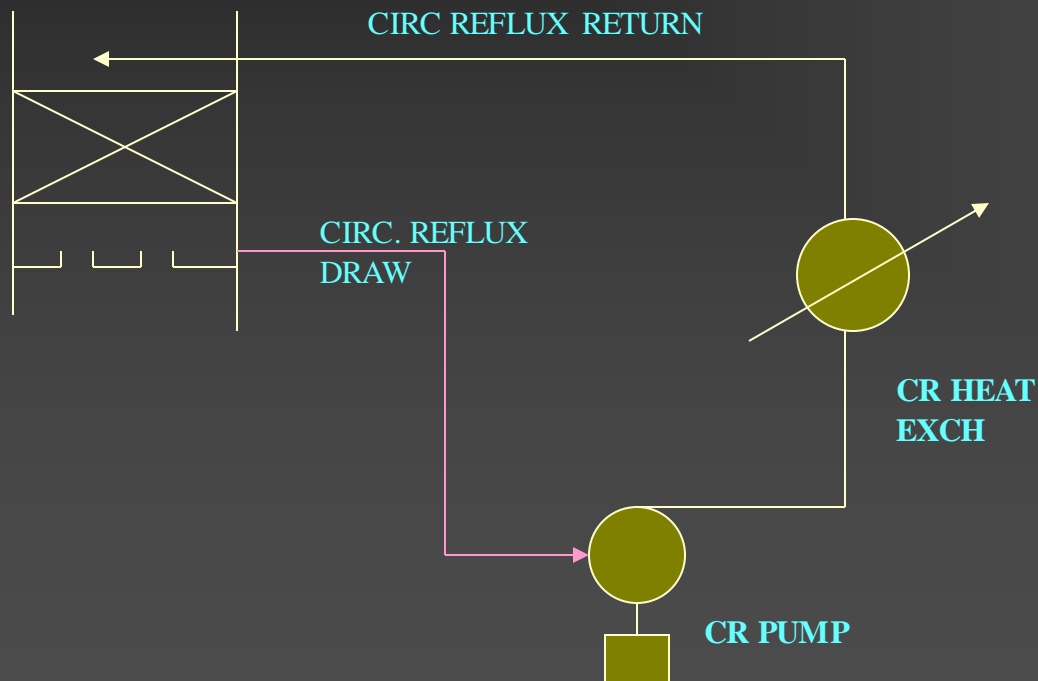
GAS PIPELINE –RECEIPT TERMINAL



PIPELINES-WHAT COULD GO WRONG?

- INCOMPATIBLE BATCH TRANSPORTATION
 - OPENING/CLOSING OF MANUAL/SECTIONALIZING VALVES DURING OPERATION
 - INSTRUMENT MALFUNCTIONING
 - COMMUNICATION FAILURE
 - IGNORING ALARMS
 - PRODUCT DIVERSION TO WRONG TANKS
-

CORROSION –POTENTIAL AREA



LOCATION—HVY NAPHTHA CR SECTION

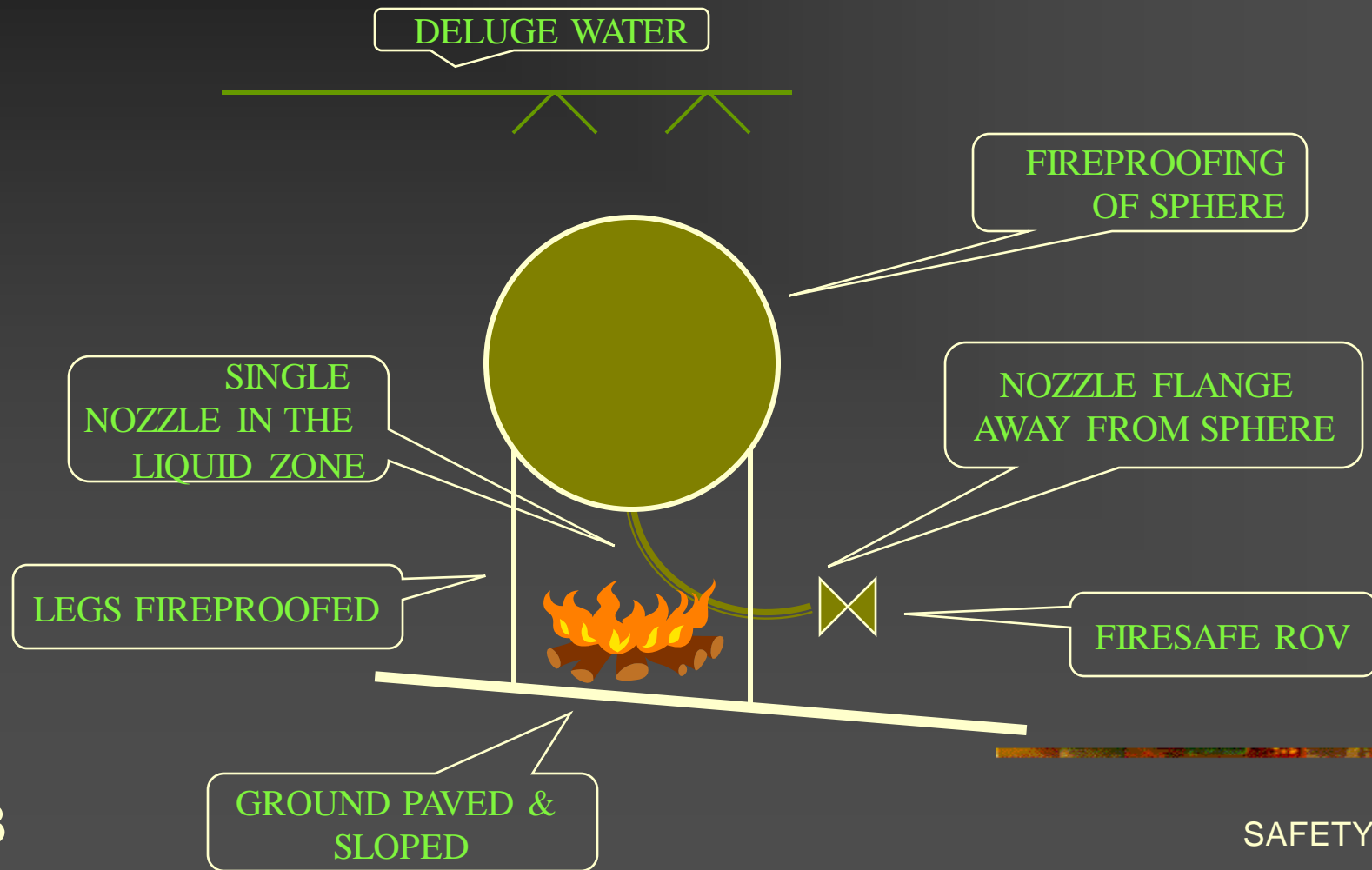
PROBLEMS

- LOW CR RETURN TEMPERATURE
- HIGH HEAT PICK UP
- LOCAL WATER SUPERSATURATION
- CORROSION IN DRAW OFF PIPING
- DESIGN PRESSURE IS IN ORDER BUT DOES NOT HELP

STORAGE SYSTEMS

- NOT A HIGH PRESSURE FACILITY BUT CAN LEAD TO HAZARDOUS SITUATIONS
- INSTRUMENT MALFUNCTION AND OVERFILLING OF TANK
- FIRE IMPINGEMENT ON UNWETTED PORTION OF SPHERE OR BULLET CAN LEAD TO METAL FAILURE AND BLEVE

SAFETY IN DESIGN

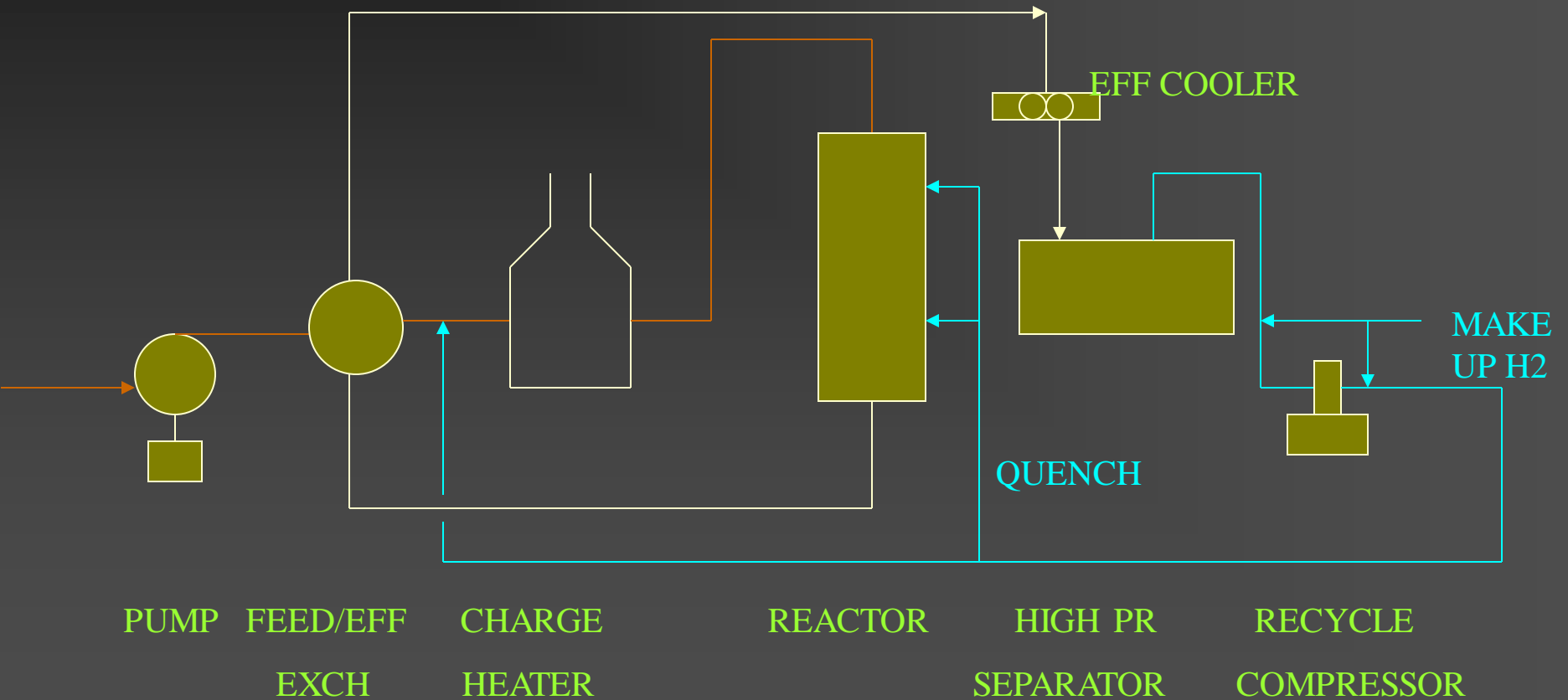


STORAGE SYSTEMS

- CHECK RELIEF VALVE SET PRESSURE IN CASE OF CHANGE OF SERVICE
- BUTANE STORAGE IN PROPANE/PROPYLENE SPHERE
- VESSEL MAY FAIL ON ACCOUNT OF HIGH METAL TEMP BEFORE ATTAINING THE RELIEVING PRESSURE



HYDROPROCESSNG-SIMPLIFIED SCHEME



HYDROPROCESSING-ISSUES TO BE CONSIDERED

- REACTIONS ARE EXOTHERMIC-QUENCH RATES DEPEND ON FEED QUALITY, CONVERSION, SATURATION
- RG COMPRESSOR CAPACITY BASED ON H₂/HC RATIO, QUENCH AND H₂ PARTIAL PRESSURE
- START UP-EXOTHERMICITY MAY BE LOW, FEED RATES AT TURNDOWN LEADING TO LOW QUENCH REQMTS
- IMPLICATIONS—LIMITATIONS ON COMPRESSOR PERFORMANCE, HEATER HYDRAULICS, FLOW PATTERNS (VIBRATION IN SOME SECTIONS)

HIGH PRESSURE EQUIPMENT

- REACTORS
- SEPARATORS
- COMPRESSORS

THESE ARE DESIGNED WITH ALL
PRECAUTIONS TO ENSURE PROCESS
AND MECHANICAL INTEGRITY OVER A
WIDE RANGE

HIGH PRESSURE REACTORS

- DESIGN PRESSURES AND TEMPERATURES TAKE CARE OF NORMAL OPERATION AND REGENERATION
- MOC ACCOUNTS FOR THE FLUIDS BEING HANDLED
- UNDERSTANDING OF PROCESS RELATED ISSUES ESSENTIAL TO AVOID PROBLEMS

POTENTIAL PROBLEMS

- AVOID RAPID COOL DOWN AND ALLOW SUFFICIENT TIME FOR DEGASSING
 - TEMPERATURE EXCURSIONS
 - FEED QUALITY CHANGES-AFFECT REACTION RATES AND HEAT RELEASE
 - PRESENCE OF HYDROGEN SULPHIDE-ADDS TO HAZARD POTENTIAL-LEAKS TO BE ATTENDED DURING SHUT DOWN ONLY
 - SIZE DEPRESSURISATION SYSTEMS ADEQUATELY
-

RECOMMENDATIONS

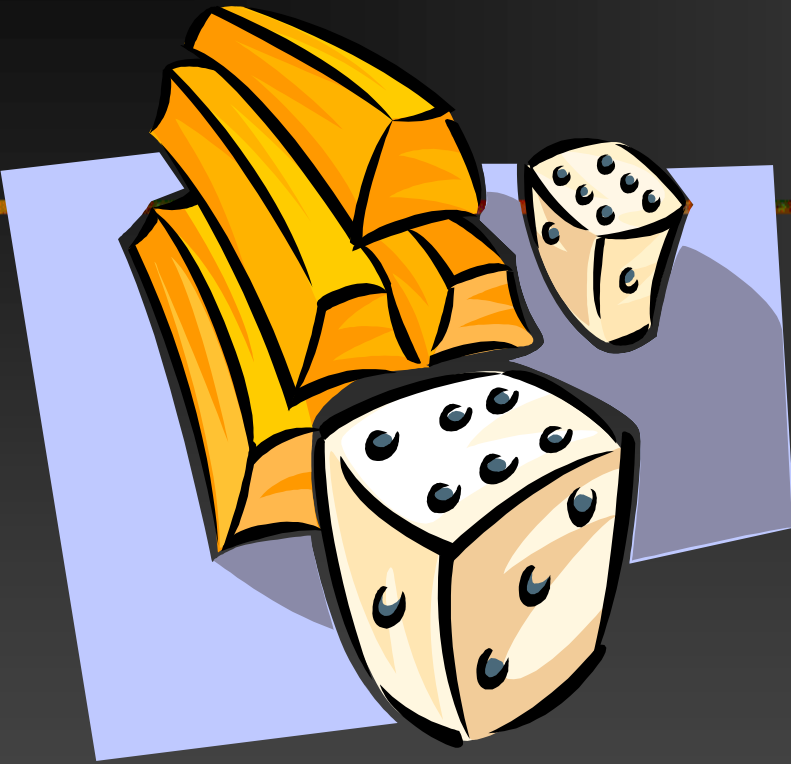
- BASIC ENGG DESIGN DATA NEEDS THOROUGH REVIEW-ONCE FINALIZED COMPLIANCE SHOULD BE ENSURED
 - FOLLOW STANDARD CODES FOR DESIGN/ENGG
 - ANTICIPATE TRANSIENTS AND PROVIDE FOR THEM IN DESIGN
 - PROCESS SPECIFICATIONS TO REFLECT NORMAL AS WELLAS START UP CONDITIONS
-

RECOMMENDATIONS

- REVIEW DOCUMENTS FOR COMPLETENESS AND CORRECTNESS INVOLVE OTHER DISCIPLINES ALSO TO VERIFY
- ✓ CORRECTNESS OF MATERIAL OF CONSTRUCTION
- ✓ CHOICE OF CORRECT PIPING MATERIAL SPECIFICATIONS –GASKETS TEMPERATURE LIMITATIONS,ETC
- ✓ CONFORMITY WITH HAZARD AND OPERABILITY STUDY RECOMMENDATIONS
- ✓ PLANT LAYOUT

CONCLUSIONS

- PLANT SAFETY IS AS IMPORTANT AS PROCESS PERFORMANCE-CANNOT BE COMPROMISED
 - MULTIDISCIPLINARY ISSUE
 - REQUIRES GOOD UNDERSTANDING OF PROCESS AND OPERATING VARIABLES
 - GOOD OPERATING PRACTICES ARE ESSENTIAL
 - DO NOT FLOG A PLANT WITHOUT PROPER UNDERSTANDING OF DESIGN LIMITATIONS
-



DO NOT GAMBLE WITH SAFETY



THANK YOU