SAFETY DESIGN CHECKLIST

PS/MOC No:

(Rev. Date 5/6/14)

(n/a = not applicable u = unresolved)

1.0	**EQUIPMENT LAYOUT**	yes	no	n/a	u
1.1	Does the plot layout meet all spacing standards?				
1.2	Does the plot plan layout change the facility siting study?				
1.3	Is equipment access & lighting adequate, and if not, the requirement for improved access & lighting identified in the specification (e.g. fire fighting, operation, etc.)?				
1.4	Has the impact of the installation of the new facilities relative to the existing facilities been evaluated?				
1.5	Are there any new physical hazards introduced to the existing facilities by installing new facilities?				
1.6	Have obstructions – underground & overhead – been identified (e.g., power lines)?				
2.0	**EXISTING FACILITIES**	yes	no	n/a	u
2.1	Are pressure/temperature ratings compatible with new facilities?				
2.2	Has reused idle piping or equipment been tested and certified for the new process conditions?				
2.3	Has the impact on unit and/or refinery safety (SV's, B/D, flares, etc.) been evaluated?				
2.4	Has the impact of the new facility on the existing facility (e.g. temperature, radiant heat, vibration) been evaluated?				
2.5	Has the impact of the existing facility on the new facility (e.g. temperature, radiant heat, vibration) been evaluated?				
2.6	Are all dismantling requirements identified on the P&IDs?				
2.7	Have interfaces with atmospheric storage tanks and other operating units been evaluated?				
3.0	**PRESSURE / TEMPERATURE CONTINGENCIES**	yes	no	n/a	u
3.1	Have special operations been considered (e.g., catalyst regeneration, chemical cleaning, water wash, steam out)?				
3.2	Have the effects of S/U, SID and upsets been evaluated (e.g., vacuum due to rapid liquid pulldown, chemical cleaning, water wash, steam out)?				
3.3	Has the potential for leakage into standby equipment and the potential for a resultant overpressure been considered?				
3.4	Has the effect of centrifugal pumps in series and spare pumps been considered?				
3.5	Have exchangers been designed so that the high pressure side design pressure is no more than 1.3 times the low pressure side design pressure? (1.5 times for exchangers built prior to 1999)				
3.6	Are low pressure systems protected from high pressure gas when loss of level occurs?				
3.7	Has use of the short term overpressure allowance been avoided for piping?				
4.0	**SAFETY FACILITIES**	yes	no	n/a	u
4.1	Has the need for safety facilities been evaluated:				
4.1.a	For S/U, SID, and special operations (e.g., catalyst sulfiding, chemical cleaning, water wash steam out. catalyst regeneration)?				
4.1.b	For emergencies – fire, utilities failure, temperature runaway, etc.?				
4.2	Have new hazardous or toxic chemicals been reviewed with Industrial Hygiene & Environmental?				
4.3	Do facilities meet REP or Standard for Emergency Shutdown, Isolation & Slowdown Facilities?				
4.4	Have fire fighting facilities been reviewed with the Fire Chief?				
4.5	Have the requirements for the source of firewater and wash water (i.e. fire, potable, treated) been evaluated with respect to chloride stress corrosion cracking (CSCC)?				
4.6	Have impacts on existing Independent Protection Layers (IPL) identified by PHA/LOPA been considered?				
5.0	**INSTRUMENTATION**	yes	no	n/a	u
5.1	Have all critical instruments been designated?				
5.2	Do furnace flame-out protection systems meet REP or Standard for Piping for Fired Heaters & Boilers and Instruments for Fired Heaters?				
5.3	Do emergency isolation valves meet REP "Emergency Isolation Valve Engineering Practice?"				
5.4	Are power and control lines (including cable trays) which are designated as critical to emergency operations and are not designed to failsafe, fireproofed within fire-exposed areas?				
5.5	Has a layer of protection analysis (LOPA) been performed for this design? Have safety integrity levels (SIL) been established and safety instrument systems (SIS) been identified?				
6.0	**PRESSURE RELIEF EQUIPMENT**	yes	no	n/a	u
6.1	Is protection for thermal expansion of blocked-in liquids addressed?				
6.2	Have car-sealed open or closed valve requirements been identified?				
6.3	Has the use of ruptures disks for pressure relief been avoided?				
6.4	If a rupture disk is required upstream of a safety relief valve, is the space between the rupture disk and the safety relief valve desjgned for proper venting per API 520 and the REP?				
6.5	If bellows type safety relief valves are used, are they required for backpressure purposes and has the disposition of the bonnet vent been considered?				
6.6	If pilot-operated safety relief valves are used, have all options to allow for a conventional type safety relief valve been reviewed?				
6.7	If insulation is used in the safety relief valve fire contingency calculation, does the insulation meet the reouirements in API-521?				
6.8	Pressure Relief Device (PRD) Documentation:				
6.8.a	Has the design added a new relief device or modified an existing one?				
6.8.b	If ves. Has the documentation been provided or updated in the required format to the Flare Master and PCMS been updated?				
6.8.c	If no, is this an in-kind replacement?				
6.8.d	If yes, has the PCMS been updated?				
6.9	Safety relief valve piping:				
6.9.a	Is inlet line max delta P< 3% of set pressure?				

6.9.b	Is outlet line velocity < 75% of sonic?				
6.9.c	Are liquid traps in the vapor piping eliminated?				
6.9.d	Are inlet and outlet block valves CSO? Are valve stems parallel to the ground?				
6.9.e	Has the potential for plugging been addressed *(e.g.,* coke, catalyst, salts)?				
6.10	Have atmospheric safety relief valve discharges been checked regarding toxicity, liquid fallout, flammability, radiant heat flux if ignited, the need for snuffing steam, potential for vapor cloud explosion, and odor?				
7.0 UTILITIES		yes	no	n/a	u
7.1	Are utility supplies (steam, air, N2, electrical) adequate?				
7.2	Do utility tie-ins meet REP or Standard for Utility Connections to Piping & Equipment Design, and if connections are temporary, do tie-ins meet SWP 402 (Section 9-402)?				
7.3	Has the electrical area classification been checked?				
7.4	Has the potential for a process fluid to leak into a utility stream (e.g. in a heat exchanger) been considered?				
7.5	Have new underground facilities been reviewed with utilities personnel?				
8.0 SPECIAL ITEMS		yes	no	n/a	u
8.1	If TCPA equipment are involved, does the design comply with the requirements of TCPA 7:31-4.11 (New Processes) or 4.6 (MOC)?				
8.2	Do water draw-offs from light hydrocarbon vessels have double blocks and meet API-2510 and 2510A as well as the appropriate REP or standard?				
8.3	Does the design avoid and eliminate dead legs?				
8.4	Have the effects of flashing and auto-refrigeration been considered?				
8.5	Have static electricity concerns been addressed (e.g., filters, atmospheric storage, barges, truck)?				
8.6	Have brittle fracture concerns, wet H2S/CN-service and corrosion probe installations been addressed?				
8.7	Has winterization been addressed?				
8.8	Is personnel protection insulation adequate?				
8.9	Is fireproofing adequate?				
8.10	Does the design avoid the following:				
8.10.a	Stopples and Plidco Fittings?				
8.10.b	Chain Wheel Operators?				
8.10.c	Bellows Expansion Joints?				
8.11	If hot taps are required, has the risk to cost been evaluated and reviewed with the Business Team and HSE representative ?				
8.12	Are double block valves provided where required by REP or Standard?				
8.13	Have excess flow valves been provided on level glasses in toxic or flammable high pressure services as required by REP or Standard?				
8.14	Has the need for a manual reset on trip valve solenoids been evaluated?				
8.15	If a mix point or injection point has been added or altered, is the design consistent With Required Standard M-42-RS-5? Has inspection team been notified of this change to the mix point / injection point?				
8.16	For physical or operational changes to piping or equipment in sulfidation service, has Inspection / Materials Engineer reviewed the scope, consistent with Required Standard M-42-RS-3?				

NOTES:

TEAM LEADER'S NAME:	
TEAM LEADER SIGNATURE:	**DATE:**

GLOSSARY AND DISCUSSION OF TERMS (Appearing in order used)

PS/MOC No: Process specification/Management of change Number.

PS: Process specification. This is the engineering description of the process as approved by process management. It would be the engineering design document reduced normally to wordage along with design P&ID or similar, and a description of the process, the reasons for the process design (safety, environmental or dollar return), and the hazards and mitigations of that design.

MOC: Management of change. This is the control system in place to ensure review of any changes to an existing process (usually relatively minor changes). For example, if this was a design change to replace a control valve from a ball valve to a plug type, with pipe and metallurgy remaining the same, it would be a MOC rather than a PS. If this was the redesign of an entire system, such as replacement of the piping from 6-inch carbon steel to 8-inch 9% chrome with an 8-inch plug type control valve, it would likely require a complete engineering process design, and therefore a PS. Different levels of review are required based on the complexity and corresponding the potential for serious consequences, with the PS being the highest level of review.

SV: Safety valve or relief valve. Obviously if you are making a change you need to review if the safety relief capability needs upgrading or downgrading. This would be unlikely for the MOC above where you were only changing the valve type but more likely where you are in the pipe dimension upgrade as well as the metallurgy upgrade. If for example you were going to the 9% chrome mentioned above I would assume that you planned to run the system much hotter, and perhaps the SV would have to increase in size and it might also have to change metallurgy to accommodate higher pressures/temps.

BD: Blow down; refers to the pipe system or drum system used to remove pressure from the systems. It also includes flares or recovery pipe systems within the refinery. Concerns in these systems include flashing in the pipe systems and resulting cooling of the systems (killed steel or stainless might be required) or plugging or fouling and loss of flow type scenarios. Tracing and insulation might be needed or some additive to preclude or prevent fouling.

S/U or SU: Abbreviation for start up, and includes also shut down (SD) effects. A recent example comes to mind. A CO boiler design was being constructed at a cat cracker in NJ and one of the design criteria was to eliminate as many small connections/fittings as possible on the 750 PSIG steam grid, as they are a site of many leaks during operation. At the same time, control valves for steam production were routed to grade level to allow maintenance without platform construction. During the pre-startup review, it was noted that small bore drains were needed on the inlet and outlet of the CVs to allow condensate drainage during SU and SD periods when the temperatures were not up to the standard high levels, which would preclude the condensate formation.

SID: Abbreviation safety in design. This refers to inherently dangerous and inherently safer practices. Whenever possible, you always try to design the inherently safer procedure. Failure to avoid inherently dangerous practices requires another level of management review and oversight. An example in the refinery might be the requirement with reformation or catalytic reformation using platinum catalyst that requires the chlorination of the catalyst to activate it

prior to use. An inherently dangerous practice would be to use chlorine gas to perform this chlorination. An inherently safer procedure would involve the use of hypochloride. For your purposes, I would develop a list of items that you want to avoid due to high risk. In the lab for example, I do not think you want to work with chlorine, peroxides over a certain strength, picric acid, benzene, exothermic reactions that have the potential to run away. (for example, in an exothermic polymerization reaction, I would slow-add the monomer to the initiator, catalyst rather than dumping the initiator/catalyst into a pool of monomer.) This would be an example of an inherently safer practice. You still can do these types of activities but they require much more oversight and the tendency is to do everything possible to avoid them. Another example that comes to mind is the type of nuclear reactor at Chernobyl. If you did a SID review on this reactor and noted that it could run away at low turn down you would likely at least ensure your procedures spelled out not to try to run the reactor at low levels. More likely you would utilize another design that did not have the risk. I would imagine that this list would need to be formalized and referred to in this section.

REP (Items 4.3 and 5.2): Abbreviation for the engineering design criteria for the company for a certain type of equipment. The one highlighted here is for emergency shutdown, isolation and slowdown facilities. An example of what this might say is for LPG facilities, automatic functioning shut down valves with fire tight seals and actuators would be required to mitigate the risk of uncontrolled vapor generation and potential ignition. I would look at the consequences of the experiments and the control factors and decide what local standard shut downs you need for each process. The same applies to pipe for fired heaters and boilers and instruments for fired heaters and for emergency isolation valve engineering practices. Each has different risks, what are your standards to use each? There should be a procedure developed if there is not one already.

REP (Item 6.4): Again refers to the use of a REP or refinery engineering practice if you have a rupture disk upstream of a safety relief valve. The concern is that the disk must rupture completely enough so the Safety valve sees all of the pressure and can vent it in an acceptable time frame (before the vessel fails). Usually a rupture disk is placed upstream of a relief valve to keep a corrosive process fluid from damaging the safety valve or if the product is difficult to keep from leaking through the fittings of the Safety valve.(hydrogen comes to mind as it will likely leak through most gaskets, ports etc) This rep specifies the distance between the SV and the rupture disk to prevent a piece of the disk from damaging the SV and calls for a remote reading instrument to alarm if the disk fails or ruptures. You probably do not need this in your operations but I would review with your instructors before dumping this. In the refinery, a senior operations manager is in overall control of the flare systems as they must be kept from additions that are not within system capacity both from a safety and an environmental side. An example might be the addition of a relief valve from a tower that would add 100CFM of propane gas to the flare system if it should receive. If the flare system only has 50 CFM of additional capacity, obviously this additional capacity cannot be added without expanding the flare grid as the grid is designed for worst case. From the environmental side, the addition of H2S gas from a relief system is strictly controlled and monitored. In your case I am not certain

that you have a flare system, perhaps a simple review of the emergency venting, does the reaction need to be in a hooded area is all that is required.

PCMS: Process change management system. Any and all changes to current operations require documentation. For example, the replacement of a 4 inch ball valve with a 4 inch gate valve requires a simple management of change form with P&ID updated (or whatever you might use at your level) and review by a senior operations manager before start up. As the complexity of the change increases, the review by senior management becomes more involved and may require additional members and sign offs prior to start up. As an example when we built a replacement furnace for the pipe stills, the PCMS involved required a team lead by a senior manager not involved in the process involved with a team of more than 20 specialists to review each and every aspect of that furnace as built. It took almost six months while under construction and produced more than 1500 exceptions that had to be reviewed and approved prior to start up. All of this documentation is kept for the life of the unit and is available for review in the future.

CSO: The inlet valve and outlet valve to a safety relief valve with a car seal or numbered metal or plastic ribbon type device through the stem/wheel area of the valve. In order to close the valve the tag must be broken off and returned to management for record keeping. Car-sealed open prevents an operator from closing one of these critical valves and thereby removing a relief valve path. In addition, these valves are painted yellow to give visual warning. An operator can only close these valves when directed by management usually to allow maintenance on the SV.

REP (Item 7.2): Refers to the engineering practice that allows connections between process equipment and utilities. The concern is leakage of the process fluid into the utility system mostly but also leakage of the utility uncontrollably into the process stream. An example might be a water wash connection and the standard would be to have a block valve at the process connection, a pressure gauge on the utility side of the block valve, a check valve facing into the process stream of compatible metallurgy to the process steam, a bleed valve and a second block valve, pressure gauge and bleed valve between the check valve and the utility. The gauges give visual warning of pressure obviously and indicate leakage where it is not wanted. The intent is for the water stream to enter the process ONLY and to keep the process stream from ever leaking back out. For your purpose, I would show a simple one line diagram of an allowable utility connection to process equipment. I would NOT allow connections between drinking water and process equipment in your facility without the use of a break tank. Too easy to feedback even with check valves or even back flow preventers.

SWP402: This is a salt water procedure in and is not applicable to your operation.

TCPA 7:31-4.11: This is a level of regulation only required in NJ for new processes and is not applicable to your operation.

HSE Representative (Item 8.11): You are not performing any hot taps. If you were doing this, operations management and HSE or Health, Safety and Environmental manager must review before welding on a live hydrocarbon or air line.

REP (Item 8.12): REP defined previously. Normally double block valves are required where tight shut off must be guaranteed. An example might be to isolate a utility from a process fluid or if welding on a steam line which cannot be blanked away or otherwise isolated. Usually a bleed valve is required between the blocks and it is opened to confirm no leakage at either valve.

M-42-RS-3 (Item 8.16): Sulfidation is a very sensitive, hazardous operation. It requires special metallurgy and maintenance as metal failure or failure to follow strict maintenance protocols on prepping for mechanical work can cause fires or other failure. If you do not perform any sulfidation reactions I would eliminate this.