

# Global Competence Management for Process & Plant Safety at Bayer

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Excellence in the field of process and plant safety (PPS) is indispensable and a consistently high level of safety has to be achieved in all processes and facilities within the Bayer Group worldwide. Global PPS competence has been identified as one important pillar in managing process safety at Bayer. This paper deals with the research questions of how a holistic concept can look like in order to safeguard a high level of PPS competence across all levels of the organization and specifically at PPS expert level. For this purpose a global competence management system based on four key measures (or initiatives) is presented: Besides the development and certification of PPS Practitioners, introduction of PPS corporate standard solutions and support practices, and active PPS community management this paper introduces a novel concept with regard to a quality assurance system for process hazard analyses (PHAs). The ultimate objective of these initiatives is to implement a globally uniform, consistent and quality assured system for PPS.

## 1. Motivation

### 1.1 Typical Process Hazards at Bayer Operations

Bayer is a global enterprise with core competencies in the fields of health care, agriculture and high-tech polymer materials. Its operations comprise the production of chemical products and active ingredients in either continuous running plants or batch-operated processes. In addition, many formulation, filling and packaging units continue material processing and convert chemical products into a finished and applicable form, e.g. a pharmaceutical form for medicine. Many different process risks come along with these operations. A few of them which are most evident are for example chemical hazards of toxic materials, thermal decomposition hazards of solid and liquid materials, dust and gas phase explosion hazards, occupational and machinery hazards, incl. industrial hygiene hazards. In order to cope with these process risks a sound and state-of-the-art process safety management system is required. As process safety competence is one important pillar in a successful process safety management system, this paper aims to explain a new concept for global PPS competence management and PHA quality assurance. The establishment of a systematic PHA quality assurance system is a new means to not only ensure a consistently high quality level in terms of documentation and formal requirements, but also to globally harmonize safety concepts and safety culture.

### 1.2 The Starting Point: Bayer TOPPS Initiative

Starting from 2010 Bayer has launched a board initiative called 'Top Performance in Process and Plant Safety' (TOPPS) in order to identify room for improvement in the field of process and plant safety and to ensure a desired high level of PPS performance at all Bayer production facilities and plants. In general, room for improvement has been identified in the areas of management commitment, organizational structure and community management. Based on these results a set of measures has been defined and successfully implemented in Bayer at group and also business unit level. Those measures comprise for example (non-exhaustive):

- an enhanced monitoring and control of PPS performance,
- advance communication concepts to increase awareness for PPS topics,
- a systematic PPS training approach throughout the Bayer organization,

- an increased availability and accessibility of PPS expertise in every region, and
- organizational structures to maintain the desired level of PPS.

### 1.3 Future PPS Challenges at Bayer

All of the TOPPS measures could significantly contribute to improve PPS performance and foster safety culture and awareness at Bayer. However, in order to advance process and plant safety and bring it to the next level it was decided to introduce a global PPS competence management system. The aim of this initiative is to cope with basically four future challenges which have been identified as most relevant in the area of process & plant safety:

1. People & competence
2. Quality of process hazard analysis (PHA)
3. Global PHA coverage of all facilities, plants and processes
4. Efficiency in conducting PHA and safety reviews

The meaning of these challenges will be briefly explained below.

**People & competence:** People and their organizational relations are key in every process safety management system. It is essential to ensure the appropriate degree of PPS competence across all levels of the organization from PPS specialist to operator. This includes a proper definition of what needs to be known and which skills need to be available at which level of the company including senior management and even CEO level. One has to globally cope with for example different cultural backgrounds, standards of knowledge, and high people turnover especially in Asian countries.

**Quality of process hazard analysis (PHA):** Due to acquisitions, different local and cultural backgrounds, or varying capabilities of PHA facilitators worldwide, process hazard analyses can differ in shape, content and quality. However, the intention is to have globally uniform and consistent process hazard analyses with consistent risk assessments and aligned safety concepts for similar process hazards. For example comparisons have shown that consequences of similar high pressure scenarios have been estimated differently in different parts of the world. These deviations would require a global alignment of all PPS experts worldwide on how process risks should be evaluated and tackled.

**Global PHA coverage of all facilities, plants and processes:** As per the corporate regulation every operation at Bayer implying (occupational or process) hazards must undergo a proper hazard analysis irrespective of what method will be applied: a thorough Hazard and Operability study (Hazop), a job safety analysis, or a checklist. The intention must be to accomplish a comprehensive PHA coverage of all operations globally ('No white spots') and to capture for example also areas which have not been in the focus of PPS, such as gasoline unloading stations for farm machines or animal litter silos. In order to achieve this, it is essential to have the right set of competencies and the appropriate number of experts and PPS resources available in all regions.

**Efficiency in conducting PHA and safety reviews:** PHA efficiency means to increase utilization of best-practices, PPS standard solutions, and support practices in order to provide harmonized safety concepts worldwide and expedite the workflow of a process hazard analysis. However, the type of hazard as well as the nature of operations can be rather different. It might pay off to apply a sophisticated PHA methodology to a complex and rather difficult to understand process while an easy-to-use checklist can be the right tool to assess machinery hazards at standard machines.

### 1.4 Key Principals for Managing PPS Competence

In order to cope with above mentioned challenges a framework of 9 principles has been defined at Bayer to systematically manage PPS competence:

- Commitment to state-of-the-art, high quality safety reviews at all Bayer sites
- The corporate PPS Center-of-Expertise at Bayer develops, provides and teaches required PPS support practices to the global PPS community
- The corporate PPS Center-of-Expertise at Bayer leads the global PPS community independent of reporting lines including training and developing of all Bayer PPS Practitioners
- Bayer PPS Practitioners shall be active members of the PPS community and shall obtain regular training

- Safety reviews shall be performed by certified fulltime PPS Practitioners in interdisciplinary teams under control of the corporate PPS Center-of-Expertise at Bayer
- Quality of all safety reviews shall be cross-checked and audited by the corporate PPS Center-of-Expertise at Bayer
- Safety reviews performed by external (third-party) services shall be approved by the corporate PPS Center-of-Expertise at Bayer
- The corporate PPS Center-of-Expertise at Bayer shall define the demand of PPS Practitioners and ensure that these resources are sustained (in close cooperation with the business units)
- Regular audits by corporate auditing shall ensure the compliance with the required quality standards

Based on these 9 principles four measures have been derived to implement the global PPS competence system:

1. Development & Certification Programme for PPS Practitioner
2. Introduction of PPS Knowledge Documents and Support Practices
3. Introduction of a Quality Assurance System for Process Hazard Analyses (PHA)
4. Systematic PPS Community Management

These four measures form a holistic, intermeshed concept and should not be seen as separated individual elements. The following sections will provide a short description of each of these measures.

## 2. PPS Practitioner Development & Certification

PHA facilitators (or so-called PPS Practitioners) require both technical and soft skills as shown in Table 1 (Schmelzer et al., 2012). The way they behave in safety reviews and interact with the Hazop team members can very much influence openness and quality of safety review discussions. Furthermore, a PPS Practitioner is much more than a moderator of an organized brainstorming of what can go wrong in a plant or process. Based on a thorough process understanding he or she must be able to identify related process risks and evaluate properly their consequences to people and environment.

*Table 1: Required technical and soft skills of a PPS Practitioner (non-exhaustive)*

Technical Skills	Soft Skills
Can apply (various) safety & PHA methodologies	Leads, moderates & motivates interdisciplinary Hazop teams
Knows safety concepts & technical measures	Questions assumptions and challenges given information
Has a sound scientific understanding	Thinks lateral
Has a thorough process understanding	Communicates actively
Is able to evaluate material hazards	Acts socially responsible and convinced
Knows and identifies fire & explosion hazards and appropriate protection concepts	Works interdisciplinary, but free of peer pressure
Knows and identifies chemical & thermal hazards and appropriate protection concepts	Examines carefully and respects details
	Is assertive
	Balances safety, operability & economics
	Tries to get the bottom of the problem

### 2.1 PPS Practitioner Development and Certification Programme

Bayer has introduced a four-stage development programme in order to achieve a high-quality competence for its PHA facilitators (PPS Practitioner). This program must be accomplished before Practitioners are allowed to start facilitating process hazard analyses (see Figure 1). The four development steps stipulate the following:

**Step 1 and 2 (Sound Basics & Mandatory PPS Specialist Trainings):** Starting with a sound academic education in natural science or engineering or preferably with work experience from production or process engineering, beginners have to undergo an on-boarding programme to get familiar with the main disciplines and skill requirements (see also Table 1). Additionally, a PPS expert training and a course on PHA facilitation are mandatory. Both trainings are internal and specifically customized to meet Bayer expectations.

**Step 3 (Mentoring & Guidance):** Beginners will be assigned to senior colleagues who act as a mentor and supervisor. At the beginning mentor and mentee jointly conduct the safety reviews with the mentee being an observer and scribe. Later the mentee takes over PHA moderation for smaller parts under the supervision of the mentor until the mentee is capable of leading the PHA stand-alone. After having finished an appropriate number of safety reviews independently the mentee will be certified by two acknowledged PPS experts and approved by the Bayer Corporate PPS Platform. Only certified PPS Practitioners are entitled to conduct process hazard analyses at Bayer.

**Step 4 (Continuous Improvement & Refresher Trainings):** In order to maintain and advance PPS competence every PPS Practitioner must participate in regular experience exchanges, internal and external trainings, and in internal PPS conferences and symposia. With increasing operating experience the PPS Practitioner can evolve into a Senior PPS Expert – preferably with key activities on a specific subject matter topic (e. g. explosion protection or chemical safety).

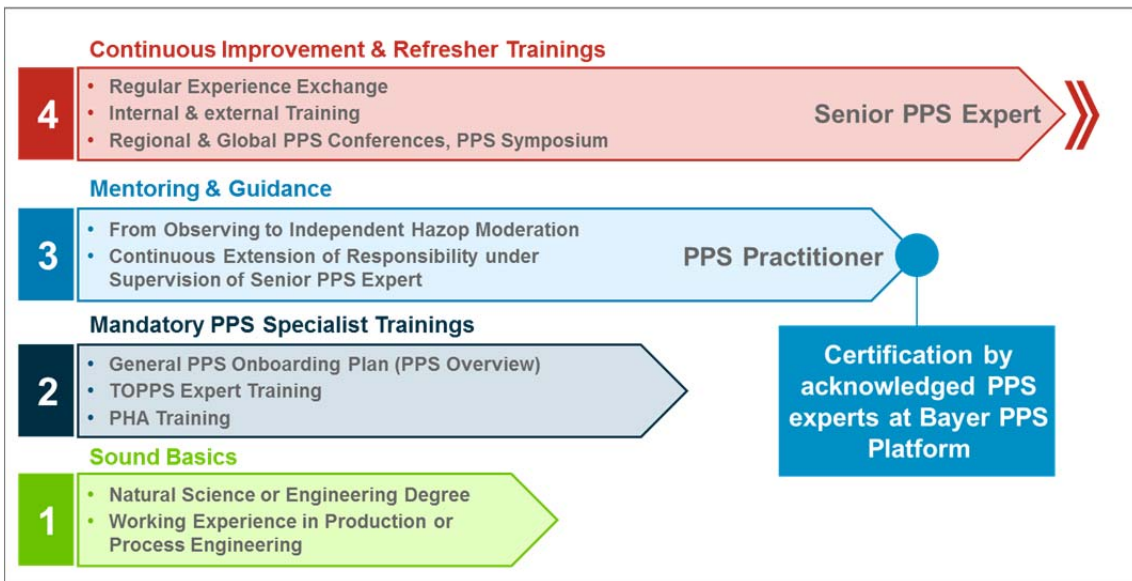


Figure 1: PPS Practitioner Development & Certification Programme

**2.2 PPS Training Programme at Bayer**

Besides having competent subject matter experts and knowledgeable PPS Practitioners it is essential to have a solid and adequate PPS competence across all levels of the organization. Therefore, a customized PPS training for each target group and category was established at Bayer. The PPS training programme is based on a train-the-trainer concept as is indicated in Figure 2. PPS experts will train prospective PPS Practitioners in an 8-days seminar. Regional or local HSE managers who have received a 3- to 4-days training will train operators, shift managers and other production personnel on site in a 2-days training.

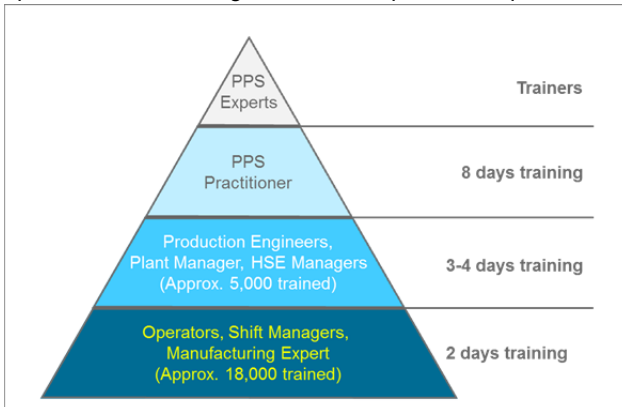


Figure 2: PPS Training Programme based on a Train-the-Trainer Concept

Nine different learning modules cover a wide range of PPS topics encompassing for example explosion and chemical risks, case histories, lessons learnt, PHA methodologies, safety concepts and installations, regulatory affairs, and safety management systems. This training programme has been rolled-out globally with multilingual training material in 15 different languages. Up to now approximately 26,000 participants have been trained. In addition to the regular classroom trainings, a web-based training in German, English, Mandarin, and Spanish will be introduced this year for operators. This training programme is an ongoing effort with refresher trainings for each category on a regular basis.

### 3. PPS Knowledge Documents and Support Practices

PPS knowledge documents are Bayer-internal PPS standard solutions and support practices that are made available to the global PPS community on a common file share. They are globally applicable and meant to support Practitioners and safeguard uniform and consistent high-quality PHAs. In the past it has been perceived that consistency with respect to risk assessments and safety provisions is an issue that needs to be improved. For this reason PPS Knowledge Documents have been introduced in order to provide guidance. Besides this an active PPS community management has to ensure a continuous exchange of views and sharing of experiences amongst PPS Practitioners globally (see chapter 5). There are three types of PPS knowledge documents with different characteristics: Support Practices, Example Solutions, and Handbooks.

- **Support Practices** provide guidance in identifying and assessing process risks, and specifying appropriate safety measures. They should promote global harmonization of risk evaluation and safety concepts. (Examples: Identifying and Safeguarding Thermal Hazards at Distillation, Assessment of Ignition Sources at Dryers)
- **Example Solutions** are practical PHA examples for specific equipment parts or process steps taken from real safety reviews. They directly apply to or help to draw conclusions for own questions. (Example: Process Hazard Analysis of Flammable Liquid Storage in Flat Bottom Tanks)
- **Handbooks** bundle expert knowledge on a broader specific subject matter topic. They safeguard internal PPS Know-How and are used for trainings and references. (Examples: Handbook Functional Safety, Handbook Consequence Analysis)

### 4. Quality Assurance System for Process Hazard Analyses (PHA)

Process hazard analyses and resultant safety concepts play a major role in managing process risks. For this purpose Bayer is using a modified Hazop methodology to identify process hazards. An elaborated risk-based approach helps then to evaluate process risks and derive appropriate safety measures. It is essential that these safety studies are made right, consistent and on a high quality level regarding risk assessments and safety specifications. However, due to mergers & acquisitions, different historical backgrounds or varying safety awareness PHAs may differ in quality and content. In order to safeguard an appropriate and globally harmonized standard across all regions Bayer is introducing a quality assurance system for PHAs. As shown in Figure 3 various quality assurance measures are applied based on the safety criticality of the facility under investigation. In order to assess safety criticality (or the overall hazard potential in other words) for each process, plant, or operation a safety criticality score (SCS) will be estimated using a simple but still valid scoring sheet. Based on the SCS outcome the risk level of a plant and hence the requirements towards the quality assurance measures are set. This is a unique and new approach for quality management of PHAs. The following section briefly describes the required quality assurance measures for each risk level (see also Figure 3):

**Level 1:** For low risk plants with a low hazard potential quality is simply assured by a certified Practitioner fulfilling all requirements discussed in chapter 2. Low risk plants might be units with mainly occupational hazard potentials; for example standard packaging or filling machines handling non-hazardous materials.

**Level 2:** Quality assurance for moderate risk plants require an additional system audit where formal requirements are checked such as proper attendance of all required Hazop team members, completeness of documentation or decent and comprehensible structure of the PHA. It is assumed that conducting a system audit will take less than one day. Moderate risk plants imply operations that may lead to irreversible adverse health effects or significant damages.

**Level 3:** High risk plants will additionally undergo a technical safety audit in which crucial parts of a PHA are thoroughly and independently cross-checked by a second designated PPS expert. The technical safety audit is content driven and verifies for example plausibility, traceability, and completeness of the safety review and checks the adequacy of defined safety measures. High risk plants are for example characterized by handling toxic materials or volatile solvents imposing a severe fire and explosion hazard potential. Similarly, chemical

synthesis processes with high reaction or thermal decomposition energies would fall in this category. It is foreseen that technical safety audits can be accomplished within a few days.

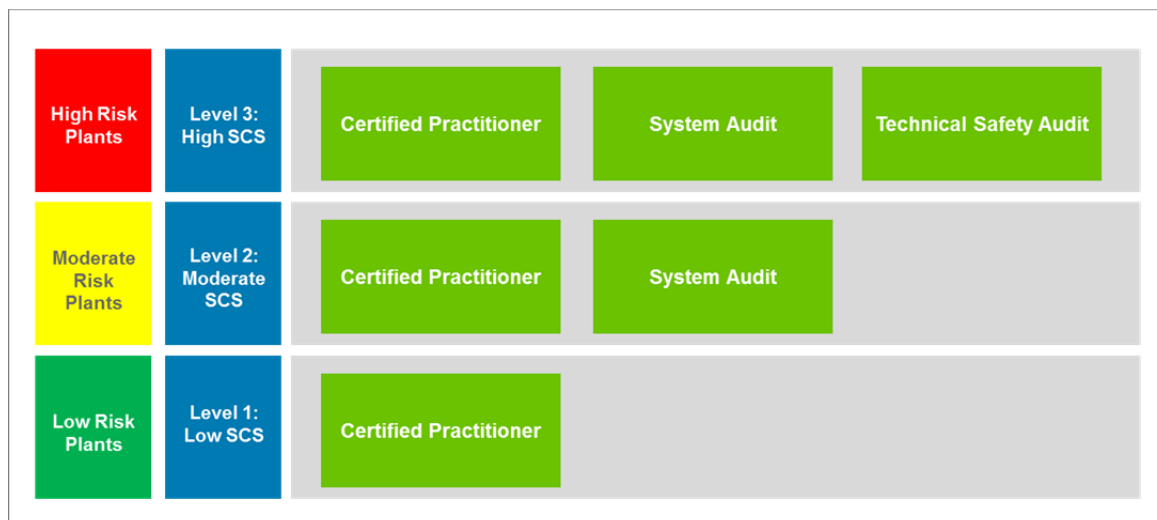


Figure 3: Measures of the Bayer quality assurance system for process hazard analyses (PHAs)

Findings or deviations from either the system audit or the technical safety audit will be discussed with the entire Hazop team in order to find a common agreement. If no agreement can be found escalation to the next management level is required. This quality assurance system applies both for PHAs (Hazop studies) in capital expenditure projects as well as for regular PHA revalidations every five years.

## 5. PPS Community Management

PPS competence management implies global experience exchange and information sharing on a regular and organized basis. This means to enable and foster collaboration between all globally distributed PPS experts and HSE managers in order to gain a common understanding on process safety and risk evaluation and increase global consistency. As PPS Practitioners work independently from their peers most of the time it is therefore all the more important to establish common platforms for all PPS Practitioners to enable calibration and alignment. Hence, Bayer has set up a global PPS community management for all stakeholders on a corporate and regional level. This includes annual regional and global subject matter meetings, a bi-annual PPS symposium and regular experience exchanges at staff level.

## 6. Conclusions

Bayer has identified that future PPS challenges require a systematic and global competence management approach in order to safeguard and maintain PPS competence across all levels of the organization and specifically at expert level. This paper presents a holistic concept based on four key measures for competence development, competence retention and competence assurance: A development and certification programme has been set up to train and enable PPS Practitioners for PHA facilitation. As an additional step PPS standard solutions and support practices as well as a thorough quality assurance system promote globally uniform, consistent and quality assured PHAs. Last but not least the integration of all globally distributed PPS members into one Bayer PPS Community will foster experience exchange and best-practice sharing.

## Reference

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