

ภาคผนวก

- ก 1 มาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อมและมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม
โครงการโรงงานผลิต Sodium Polyacrylate ครั้งที่ 1
- 2 สำเนาจดหมายนำส่งรายงานฯ ระหว่างเดือนกรกฎาคมถึงธันวาคม พ.ศ. 2565
- 3 สำเนาหนังสือแจ้งการดำเนินการหยุดซ่อมบำรุงกระบวนการผลิต
- 4 จดหมายแจ้งสถานภาพโครงการและการปฏิบัติตามเงื่อนไขรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม
- ข 1 ผลการศึกษา HAZOP
- 2 เอกสารทบทวนเหตุการณ์อุบัติเหตุ/อุบัติเหตุที่เกิดขึ้นจากการประกอบกิจการอุตสาหกรรมที่มีการผลิต
ลักษณะเดียวกันทั้งในประเทศและต่างประเทศ
- 3 ฐานข้อมูลสุขภาพของพนักงาน
- ค 1 ตัวอย่างการบันทึกระยะเวลาการใช้งานหม้อไอน้ำชุดที่ 1 ระหว่างเดือนมกราคมถึงมิถุนายน พ.ศ. 2566
- 2 เอกสารการตรวจสอบและควบคุมรักษาระดับอุณหภูมิในการเผาไหม้
- 3 แผนการซ่อมบำรุง (Preventive Maintenance) ระบบควบคุมมลพิษทางอากาศ ประจำปี พ.ศ. 2566
- 4 สำเนาหนังสือนำส่งร.3/1
- ง 1 เอกสารตรวจสอบรถขนส่งน้ำเสียด้วยระบบ GPS
- จ 1 แผนผังแสดงเส้นเสียง (Noise Contour Map)
- 2 ตัวอย่างบันทึกชนิดและจำนวนรถที่วิ่งเข้า-ออก โครงการ
- 3 คู่มือการปฏิบัติงานในการขนส่งและการขนถ่าย พร้อมมาตรการตรวจสอบด้านความปลอดภัยในแต่ละ
ขั้นตอนและแผนปฏิบัติการฉุกเฉิน
- 4 เอกสารกำกับการขนส่ง (Manifest) ระหว่างเดือนมกราคมถึงมิถุนายน พ.ศ. 2566
- ฉ 1 บันทึกปริมาณกากของเสีย ระหว่างเดือนมกราคมถึงมิถุนายน พ.ศ. 2566
- 2 รายงานการตรวจสอบ (Audit) การจัดการกากของเสีย
- 3 ข้อกำหนดการปฏิบัติงานในการจัดการของเสียในกรณีปกติ และกรณีเกิดการหกรั่วไหลของสารเคมี
- ช 1 กิจกรรมชุมชนสัมพันธ์
- 2 ขั้นตอนการรับเรื่องร้องเรียน
- 3 Isocontainer ที่หุ้มฉนวนกันความร้อน

ภาคผนวก (ต่อ)

- ซ 1 เอกสารแต่งตั้งคณะกรรมการความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการทำงาน (คปอ.)
- 2 แผนการจัดฝึกอบรมความปลอดภัย
- 3 อุปกรณ์ป้องกันอันตรายส่วนบุคคล (PPE)
- 4 เอกสารการตรวจสอบความพร้อมในการใช้งานของที่ชำระล้างฉุกเฉิน (Emergency Washing Station)
- 5 บันทึกสถิติอุบัติเหตุ ระหว่างเดือนมกราคมถึงมิถุนายน พ.ศ. 2566
- 6 มาตรการควบคุมความปลอดภัยในช่วงหยุดซ่อมบำรุง (Shutdown/Turnaround)
- 7 เอกสารการตรวจสอบการทำงานของอุปกรณ์ดับเพลิงภายในโครงการทุก 1 เดือน ระหว่างเดือนมกราคมถึงมิถุนายน พ.ศ. 2566
- 8 แผนควบคุมภาวะฉุกเฉิน ตามระดับความรุนแรง
- 9 แผนการฝึกซ้อมแผนฉุกเฉินประจำปี พ.ศ. 2566
- 10 ข้อกำหนดการปฏิบัติงานในการจัดเก็บสารเคมี
- 11 Check List สำหรับตรวจสอบ/บันทึกการทำงานของอุปกรณ์
- 12 การตรวจสอบอุปกรณ์ที่เกี่ยวข้องกับการลำเลียงสารเคมีแต่ละประเภท
- ฅ 1 แผนการตรวจสอบสุขภาพ ประจำปี พ.ศ. 2565
- 2 หนังสือนำเสนอการจัดส่งข้อมูลให้หน่วยงานสาธารณสุขในพื้นที่
- ผลการสำรวจสภาพเศรษฐกิจและสังคมของครัวเรือนประชาชนในชุมชนโดยรอบโครงการ
- ประจำปี พ.ศ. 2565
- ญ ใบรับรองผลการตรวจวิเคราะห์
- ฎ ใบรับรองการสอบเทียบเครื่องมือ
- ฏ สำเนาหนังสืออนุญาตขึ้นทะเบียนห้องปฏิบัติการวิเคราะห์เอกชน

ภาคผนวก ก.1

มาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม
และมาตรการติดตามตรวจสอบผลกระทบ
สิ่งแวดล้อม โครงการโรงงานผลิต Sodium
Polyacrylate ครั้งที่ 1

ที่ ทส ๑๐๐๙.๙/ ๒๐ ๕ ๑ ๙๙



สำนักงานนโยบายและแผน
ทรัพยากรธรรมชาติและสิ่งแวดล้อม
๖๐/๑ ซอยพิบูลวัฒนา ๗ ถนนพระรามที่ ๖
แขวงสามเสนใน เขตพญาไท
กรุงเทพฯ ๑๐๕๐๐

๑๙ กุมภาพันธ์ ๒๕๕๘

เรื่อง ผลการพิจารณารายงานการเปลี่ยนแปลงรายละเอียดโครงการในรายงานการวิเคราะห์ผลกระทบ
สิ่งแวดล้อมโครงการโรงงานผลิต Sodium Polyacrylate ครั้งที่ ๑ ของบริษัท บีเอสเอสเอฟ (ไทย) จำกัด

เรียน กรรมการผู้จัดการบริษัท บีเอสเอสเอฟ (ไทย) จำกัด

อ้างถึง ๑. หนังสือสำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม ที่ ทส. ๑๐๐๙.๙/๑๐๖๔๑
ลงวันที่ ๒๙ กันยายน ๒๕๕๗

๒. หนังสือบริษัท บีเอสเอสเอฟ (ไทย) จำกัด ที่ SAFETY BASF: 19/2014

ลงวันที่ ๑๗ พฤศจิกายน ๒๕๕๗

สิ่งที่ส่งมาด้วย ๑. มาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบ
สิ่งแวดล้อม โครงการโรงงานผลิต Sodium Polyacrylate (ภายหลังการเปลี่ยนแปลง
รายละเอียดโครงการในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมโครงการโรงงานผลิต
Sodium Polyacrylate ครั้งที่ ๑) ตั้งอยู่ในนิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด (ระยอง)
อำเภอปลวกแดง จังหวัดระยอง ที่บริษัท บีเอสเอสเอฟ (ไทย) จำกัด ต้องยึดถือปฏิบัติ
๒. แนวทางการเสนอรายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบ
สิ่งแวดล้อมและมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม สำหรับโครงการด้าน
อุตสาหกรรม โครงการนิคมอุตสาหกรรม หรือโครงการที่มีลักษณะเดียวกับนิคม
อุตสาหกรรม และโครงการด้านพลังงาน

ตามหนังสือที่อ้างถึง ๑ และ ๒ สำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม
ได้แจ้งผลการพิจารณารายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมของคณะกรรมการผู้ชำนาญการพิจารณารายงาน
การวิเคราะห์ผลกระทบสิ่งแวดล้อมด้านอุตสาหกรรมกลั่นน้ำมัน ปิโตรเลียม ปิโตรเคมี และแยกหรือแปรรูปก๊าซ
ธรรมชาติ ในการประชุมครั้งที่ ๑๙/๒๕๕๗ เมื่อวันที่ ๑๐ กันยายน ๒๕๕๗ ซึ่งคณะกรรมการผู้ชำนาญการฯ
พิจารณาแล้ว มีมติไม่ให้ความเห็นชอบรายงานการเปลี่ยนแปลงรายละเอียดโครงการในรายงานการวิเคราะห์
ผลกระทบสิ่งแวดล้อมโครงการโรงงานผลิต Sodium Polyacrylate ครั้งที่ ๑ ของบริษัท บีเอสเอสเอฟ (ไทย) จำกัด
ตั้งอยู่ในนิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด อำเภอปลวกแดง จังหวัดระยอง โดยให้เสนอข้อมูลรายละเอียดเพิ่มเติม
และต่อมา...

-๒-

และต่อมาบริษัทฯ ได้เสนอรายงานชี้แจงเพิ่มเติม ครั้งที่ ๑ ให้สำนักงานฯ ดำเนินการตามขั้นตอนการพิจารณา
รายงาน ความละเอียดแจ้งแล้ว นั้น

สำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม ได้พิจารณาข้อมูลดังกล่าว
เบื้องต้นและนำเสนอต่อคณะกรรมการผู้ชำนาญการพิจารณารายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมด้าน
อุตสาหกรรมกลั่นน้ำมัน ปิโตรเลียม ปิโตรเคมี และแยกหรือแปรรูปก๊าซธรรมชาติ ในการประชุมครั้งที่
๒๒/๒๕๕๗ เมื่อวันที่ ๒๔ พฤศจิกายน ๒๕๕๗ ซึ่งคณะกรรมการผู้ชำนาญการฯ พิจารณาแล้วมีมติให้ความ
เห็นชอบรายงานการเปลี่ยนแปลงรายละเอียดโครงการในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมโครงการ
โรงงานผลิต Sodium Polyacrylate ครั้งที่ ๑ ของบริษัท บีเอสเอสเอฟ (ไทย) จำกัด ตั้งอยู่ในนิคมอุตสาหกรรม
อีสเทิร์นซีบอร์ด อำเภอปลวกแดง จังหวัดระยอง โดยให้บริษัทฯ ยึดถือและปฏิบัติตามมาตรการป้องกันและแก้ไข
ผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อมที่เสนอไว้ในรายงานฯ อย่าง
เคร่งครัด รายละเอียดตามสิ่งที่ส่งมาด้วย ๑ ทั้งนี้ หากท่านได้รับอนุญาตจากหน่วยงานอนุญาตแล้ว สำนักงานฯ
ขอความร่วมมือท่านส่งสำเนาใบอนุญาตพร้อมเงื่อนไขให้สำนักงานฯ ทราบด้วย และเมื่อมีการเริ่มดำเนินโครงการ
แล้วจะต้องเสนอรายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตาม
ตรวจสอบผลกระทบสิ่งแวดล้อม รายละเอียดตามสิ่งที่ส่งมาด้วย ๒ รวมทั้งโครงการจะต้องปฏิบัติตามกฎหมาย
อื่นที่เกี่ยวข้องด้วย และประสานผู้จัดทำรายงานฯ (บริษัท คอนซัลแทนท์ ออฟ เทคโนโลยี จำกัด) ให้ดำเนินการ
รวบรวมรายละเอียดข้อมูลทั้งหมดตามลำดับการพิจารณาของคณะกรรมการผู้ชำนาญการฯ จำนวน ๑ เล่ม พร้อม
แผ่นบันทึกข้อมูล (CD-ROM) ในรูปของ Portable Document Format (PDF) จำนวน ๒ แผ่น พร้อมทั้ง ให้
จัดทำรายงานฉบับสมบูรณ์ที่ปรับปรุงตามข้อคิดเห็นของคณะกรรมการผู้ชำนาญการฯ จำนวน ๓ เล่ม พร้อมแผ่น
บันทึกข้อมูล (CD-ROM) ในรูปของ Portable Document Format (PDF) จำนวน ๘ แผ่น และเสนอต่อ
สำนักงานฯ ภายใน ๑ เดือน เพื่อใช้เป็นเอกสารอ้างอิงและส่งให้หน่วยงานที่เกี่ยวข้องต่อไป ในกรณีนี้ สำนักงานฯ
ได้สำเนาหนังสือแจ้งบริษัท คอนซัลแทนท์ ออฟ เทคโนโลยี จำกัด เพื่อดำเนินการในส่วนที่เกี่ยวข้องต่อไปด้วยแล้ว

จึงเรียนมาเพื่อโปรดพิจารณาดำเนินการต่อไป

ขอแสดงความนับถือ

(นายพงษ์พันธุ์ ปองทอง)

รองเลขาธิการ ปฏิบัติราชการแทน

เลขาธิการสำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม

สำนักวิเคราะห์ผลกระทบสิ่งแวดล้อม

โทรศัพท์ ๐ ๒๒๖๕ ๖๕๐๐ ต่อ ๖๘๐๒

โทรสาร ๐ ๒๒๖๕ ๖๖๑๖

ภาคผนวก ก.2

สำเนาจดหมายนำส่งรายงานฯ
ระหว่างเดือนกรกฎาคมถึงธันวาคม พ.ศ. 2565



We create chemistry

ที่ SAFETY BASF : 02/2023

วันที่ 25 มกราคม 2566

เรื่อง แบบรายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อมและมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม โครงการผลิต Advance Superabsorbent Polymers ช่วงดำเนินการระหว่างเดือนกรกฎาคม-ธันวาคม พ.ศ. 2565

เรียน ผู้อำนวยการสำนักงานนิคมอุตสาหกรรม สำนักงานนิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด ระยอง

สิ่งที่ส่งมาด้วย 1. รายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อมและมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม โครงการผลิต Advance Superabsorbent Polymers ช่วงดำเนินการระหว่างเดือนกรกฎาคม-ธันวาคม พ.ศ. 2565 (ครั้งที่ 2/2565) จำนวน 3 เล่ม
2. แผ่น CD บันทึกข้อมูล จำนวน 4 แผ่น

ตามที่ บริษัท บีเอเอสเอฟ (ไทย) จำกัดเป็นผู้ประกอบกิจการผลิต Superabsorbent Polymers ทะเบียนโรงงานเลขที่ 72230001025416 (น.42(1)-10/2541-ญอบ.) ตั้งอยู่เลขที่ 111/3 หมู่ 4 นิคมอุตสาหกรรมอีสเทิร์นซีบอร์ด ต.ปลวกแดง อ.ปลวกแดง จ.ระยอง ได้ปฏิบัติตามข้อกำหนดในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม (EIA) ซึ่งได้รับความเห็นชอบจากสำนักงานนโยบายและแผนสิ่งแวดล้อม ตามความเห็นชอบตามหนังสือเลขที่ ทส 1009.9/2041 ลงวันที่ 18 กุมภาพันธ์ พ.ศ. 2558

ดังนั้น บริษัทฯ จึงขอส่งรายงานผลการปฏิบัติตามมาตรการที่กำหนดในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม รายละเอียดตามที่ส่งมาด้วย เพื่อดำเนินการพิจารณาต่อไป

จึงเรียนมาเพื่อทราบและโปรดพิจารณา

ขอแสดงความนับถือ

ผู้จัดการอาวุโส (โรงงานระยอง)

ได้รับเอกสารแล้ว

7-คหจก

วันที่ 25 / ม.ค. / 66

ภาคผนวก ก.3

จดหมายแจ้งสถานภาพโครงการและการปฏิบัติ
ตามเงื่อนไขรายงานการวิเคราะห์ผลกระทบ
สิ่งแวดล้อม

ที่ อก 5102.3.1/ 39



การนิคมอุตสาหกรรมแห่งประเทศไทย
618 ถนนนิคมมักกะสัน แขวงมักกะสัน
เขตราชเทวี กรุงเทพฯ 10400

๗ มกราคม 2563

เรื่อง ขอแจ้งสถานภาพโครงการและการปฏิบัติตามเงื่อนไขรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม
โครงการผลิต Sodium Polyacrylate ของบริษัท บีเอสเอสเอฟ (ไทย) จำกัด

เรียน กรรมการผู้จัดการบริษัท บีเอสเอสเอฟ (ไทย) จำกัด

อ้างถึง หนังสือบริษัท บีเอสเอสเอฟ (ไทย) จำกัด ที่ SAFETY BASF : 26/2019 ลงวันที่ 8 ตุลาคม 2562

ตามหนังสือที่อ้างถึง บริษัท บีเอสเอสเอฟ (ไทย) จำกัด ได้มีหนังสือมายังการนิคมอุตสาหกรรมแห่งประเทศไทย (กนอ.) เพื่อขอแจ้งสถานภาพโครงการและการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม โครงการผลิต Sodium Polyacrylate เนื่องจากสถานะทางเศรษฐกิจและสภาพตลาดในช่วงที่ผ่านมาของบริษัทฯ ยังไม่มีความเหมาะสมที่จะลงทุนในส่วนที่ขอยกยอการผลิตรดังกล่าว ทำให้การลงทุนยังไม่ครบถ้วนตามส่วนที่ได้รับอนุมัติไว้ในรายงานการเปลี่ยนแปลงรายละเอียดโครงการในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม โครงการผลิต Sodium Polyacrylate (ครั้งที่ 1) โดยโครงการฯ ยังไม่ได้มีการก่อสร้างอาคารบางส่วน ได้แก่ ห้องควบคุมส่วนขยายอาคารเก็บผลิตภัณฑ์ส่วนขยาย ลานจอดรถส่วนขยาย อาคารปฏิบัติการส่วนขยาย ลานเก็บของเสียส่วนขยาย อาคารฝึกอบรม รวมถึงหน่วยการผลิตบางส่วนที่ยังไม่ได้ก่อสร้าง ได้แก่ หน่วยทำให้กรดอะคริลิกบริสุทธิ์ หน่วยทำปฏิกิริยาโพลีเมอร์ไรเซชันส่วนขยาย หน่วยผลิตก๊าซไนโตรเจน หน่วยผลิตน้ำปราศจากแร่ธาตุ ถึงเก็บกรดอะคริลิก Residue ขนาด 25 ลบ.ม. ถังเก็บวัตถุดิบ AU10 ขนาด 60 ลบ.ม. และถังเก็บ AU11/12 ขนาด 110 ลบ.ม. ถังเก็บน้ำเสียขนาด 250 ลบ.ม. หม้อไอน้ำชุดที่ 2 หอหล่อเย็น ขนาด 110 ลบ.ม.ต่อ ชม. หอหล่อเย็นขนาด 300 ลบ.ม.ต่อ ชม.และหอบำบัดไอชุดที่ 2 ซึ่งโครงการได้แจ้งว่าโครงการฯ ได้ปฏิบัติตามรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมที่ผ่านความเห็นชอบจากคณะกรรมการผู้ชำนาญการพิจารณารายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม ตามหนังสือที่ ทส 1009.9/2041 ลงวันที่ 18 กุมภาพันธ์ 2558 โดยโครงการฯ ขอให้ กนอ. แจ้งสถานภาพโครงการฯ ต่อสำนักงานนโยบายและแผนทรัพยากรธรรมชาติและสิ่งแวดล้อม (สผ.) ความละเอียดแจ้งแล้ว นั้น

ในการนี้ กนอ. ได้พิจารณาการดำเนินการของโครงการฯ เทียบกับรายงานการเปลี่ยนแปลงรายละเอียดโครงการในรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม โครงการผลิต Sodium Polyacrylate (ครั้งที่ 1) พบว่า โครงการฯ ยังไม่ได้ดำเนินการก่อสร้างอาคารตามที่แจ้งมา อีกทั้งโครงการฯ ได้ถือปฏิบัติตามรายงาน

/การวิเคราะห์...

การวิเคราะห์ผลกระทบสิ่งแวดล้อมดังกล่าว จากการดำเนินการของโครงการฯ กนอ. จะนำเรียนความคืบหน้าของการปฏิบัติตามรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อมของโครงการฯ แก่ สผ. ต่อไป กนอ.จึงขอให้บริษัท บี.เอส.เอฟ (ไทย) จำกัด ยึดถือและปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อมที่เสนอไว้ในรายงานฯ อย่างเคร่งครัด

จึงเรียนมาเพื่อโปรดทราบ

ขอแสดงความนับถือ



(นายอัฐพล จิรวัดน์จรรยา)

รองผู้ว่าการ ปฏิบัติงานแทน

ผู้ว่าการการนิคมอุตสาหกรรมแห่งประเทศไทย

ฝ่ายสิ่งแวดล้อม

กองสิ่งแวดล้อมและพลังงาน

โทร 0 2253 0561 ต่อ 6306

โทรสาร 0 2650 0466

ภาคผนวก ข.1

ผลการศึกษา HAZOP

Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
Functional Group	Neutralization & Trim step	FG-No.		Page 1 of 34	

Site/ Location	BASF (Thai) Ltd, Rayong, Thailand	Materials (in / out)	Glacial Acrylic Acid Caustic Soda 50% Caustic Soda 20% Soft Water Trimethylolpropane triacrylate ethoxylated (crosslinker Laromer LR9015X) 2-hydroxy-2-methylpropiophenone (photo initiator DAROCUR 1173) Alpha, alpha-dimethoxy-alpha-phenylacetophenone (photo initiator IRGACURE 651)	Rev.	Date	By	Department
Plant	Superabsorbent Polymers			1	17.06.2013	Gieger / Yongwittayakul	G-EMH/PT G-EMH/AP
Functional Group	Neutralization & Trimstep			2	05.07.2013	Juergens	AC/E
Project	The 2 nd GAA Tank						
P&ID Number	PLT-500-PD001, 002, 017, 019, 020, 022, 023, 038, 041, 043, 044						
PFD Number	9922A-PE-120-0-001a, 001b, 002, 009, 011a, 011b, 013,	Utilities	Cooling Water Chilled Water Compressed Air Scrubber				

Function of Equipment	Equipment Number	Op. Pressure p _a (bar)	Des. Pressure p _a (bar)	Op. Temp. (°C)	Des. Temp. (°C)	Materials of Construction	Volume (m ³)	Area (m ²)	Holdup (t)	Throughput (t/hr)	Remarks
Neutralization tanks	B1011, B1012	Atm to -0.15	+0.18 / -0.26	10 to 40	150	304	11.2	-	-	-	
Run-to-belt tank	B1015	Atm to -0.15	+0.81 / -0.26	12	150	304	15.0	-	-	-	
Heat exchangers	W1011, W1012	2.2	10.3	20	98.9	316	-	12	-	-	
Heat exchanger	W1016.1 W1014	2.2	10.3	12	98.9	316	-	32.2	-	-	
Heat exchanger	W1016.2 W1016	5.8	10.3	0	98.9	316	-	15.3	-	-	
Heat exchanger	W1002	3.5	10.3	54.8	98.9	316	-	17	-	-	
Pump	P1000	2.3	10	22	35	316	-	-	-	18.2	Double mech seal
Pump	P1008	2.3	10	22	35	316	-	-	-	18.2	Double mech seal
Pump	P1001	1.9	10	30	35	316	-	-	-	7.9	
Pump	P1002	1.9	10	32	60	316	-	-	-	60	
Pump	P1003	3.5	10	25	35	316	-	-	-	41	
Pumps	P1011, P1012	2.2	16	10 to 40	120	316	-	-	-	60	Mag drive
Pump	P1115	5.8	10	0	27	316	-	-	-	14	Double mech seal
Pump	P1041			30	50		-	-	-	0.01	10 kg/hr
Pump	P1051			30	50		-	-	-	0.00059	0.59 kg/hr
Static mixer	R1002		10		60	316	-	-	-		See P1001 & P1003
Static mixer	R1031		10		60	316	-	-	-		See P1008 & P1041
Static mixer	R1032		10		60	316	-	-	-		See P1008 & P1115
Stripping column	K1150	-10 mbar	5 bar	0	50	PP+FRP	-	-	-	-	See Plasticon Design

Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
Functional Group	Neutralization & Trim Step	FG-No.		Page 2 of 34	

Functional Group Intention	The major functions for monomer preparation are neutralization step (composition of sodium hydroxide, water and acrylic acid to a degree of neutralization 100%) followed by the trim step in which the degree of neutralization (DN) is brought down to a window of 40% to 85% via mixing of pure glacial acrylic acid to the DN100 sodium acrylate solution out of neutralization step. In a first step the premix caustic solution (expected maximum 22% concentration) needs to be prepared, therefore soft water pumped out of B1003 via P1003 into premix tank B1002. Also 50% caustic solution is pumped out of storage tank B1001 via P1001 into premix tank B1002. Both streams run via static mixer R1002 into premix tank. Soft water (master) is dosed inline in ratio to caustic 50% (slave). This mixture is cooled in W1002 (cooling water) to remove the heat of dilution generated by mixing of caustic and water. In a next step this pre-diluted caustic solution is mixed with glacial acrylic acid in neutralization tanks B1011 and B1012 to obtain a monomer solution with a predefined solid content (max. 36%) and a degree of neutralisation of 100%. The neutralization is done stepwise – first B1011 afterwards B1012 (batch wise operation). Also the dosage is done in steps - the premixed caustic is added first and the glacial acrylic acid follows afterwards. For each step the circulation pumps P1011 and P1012 are always running also the solution is continuously cooled down via W1011 and W1012 to remove the heat of neutralization. Target for temperature is to stay below 40°C during neutralization step. For certain products a fine tuning for solid content is necessary this needs to be done via addition of a little amount of extra soft water into B1011 and B1012 after neutralization is done. After neutralization finished the DN100 solution is pumped via P1011 or P1012 over heat exchanger W1016.1 W1014 into RTB (Run To Belt) tank B1015. The temperature of the solution after heat exchanger will then be approx. 12°C. After Run-to-belt tank the solution is cooled down to 0°C via heat exchanger W1016.2 W1016 and pumped via P1115 to static mixer R1032 (trim step). In the trim step R1032 the DN100 solution is mixed inline with glacial acrylic acid pumped via P1008 which is itself premixed via static mixer R1031 with crosslinker pumped via P1041 out of B1041. In a next step the photo initiator is pumped via P1051 out of B1051 via three inline into monomer solution pipe. Afterwards the monomer solution runs over stripping column K1150 via P1150 to polymerization belt.
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Basic Principle of the Safety Concept for this Functional Group	- Prevent uncontrolled polymerisation in neutralization tanks B1011 and B1012, RTB Tank B1015, stripping column K1150 also equipment and piping. - Make sure there is always enough water present in the solution. In the case of uncontrolled polymerisation the temperature of the monomer will always remain < 100°C through the evaporation of the water. To be intrinsically safe and also to prevent precipitation the solids content of the monomer solution has to remain < 39 wt% at all times. Also DN should be always >40. More over initiators needs kept away from monomer.
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Safety Review - BASF-HAZOP		Primary Measures		Process Safety
Functional Group	Neutralization & Trim Step	FG-No.		Page 3 of 34

- Uncontrolled polymerisation in a closed system (e.g. piping) results in a strong increase of the pressure. The pressure increases with the solids content of the solution. From 'Wärmestauprüfungen' pressures of up to 8 bars were measured at 45.5% solids (=38%GAA). At a solid content of 38% (=ca. 31%GAA) the maximum pressure build up should be below 5bar
- For a 36% solids aqueous DN100 sodium acrylate solution in principle no steam development will be expected as long as initiators kept away from the monomer solution. This is based on an extremely slow reaction speed of DN100 solution and also due to a high water content
- Dosing of acrylic acid, caustic and soft water has to be performed in such a way to remain below 38% value for solids to prevent precipitation
- In order to prevent beginning polymerisation (gel particle formation) monomer temperature inside the neutralization vessels has to be limited to 40°C. Also a circulation inside the vessels has to be ensured constantly to prevent hot spots. Hotspots can result in creating gel particles, which could cause plugging in pipes or in general is the seed for uncontrolled polymerisation. Therefore a large amount of the heat of dilution of the 50% caustic is already removed over pre dilution step in static mixer R1002.
- Temperature of the monomer solution is constantly tracked in the neutralization vessels.
- Prevent formation of solid sodium acrylate in neutralization vessels B1011 and B1012. The solubility of sodium acrylate is correlated to the solids content and neutralisation degree of the monomer solution. Precipitated sodium acrylate will plug pipes and deposit in dead spaces. Precipitated particles re-dissolve only very slowly in soft water. Precipitation can be prevented in practice by keeping solids content for DN 100 solution < 38 wt% which will be guaranteed via a trip at 37%.
- For trim step (extra addition of glacial acrylic acid to ramp down the degree of neutralization to 40%-85% which is needed for polymerisation later on) it is important that the dosage of acrylic acid is safely limited to a certain amount otherwise it could be the case that GAA content gets too high and max. pressure <5bar could be no longer guaranteed.
- Trip and Safe Operating Limit for DN100 monomer solution (Neutralization step)

Solid Content	trip 37%	SOL <38%
Degree of Neutralization	trip 95%	SOL >90%
Temperature	trip 40°C	SOL <45°C

DN	Solids	GAA bo Monomer
mol %	%	%
65	45,52	37,98
75	42,6	34,66
100	33	25,28
100	36	27,57
90	37	29,02

Note: Light green line marks maximum desired operation

point for DN100 solution

- Trip and Safe Operating Limit for DN40-85 monomer solution (Trim step)

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

Safety Review - BASF-HAZOP		Primary Measures		Process Safety
Functional Group	Neutralization & Trim Step	FG-No.		Page 4 of 34

	DN	Solids	GAA bo Monomer	Max. pressure
	mol %	%	%	bar
	65	45,52	37,98	8
	75	42,6	34,66	5,5
	75	38	30,92	< 5bar
	80	38,4	30,92	< 5bar
	85	38,9	30,92	< 5bar
	70	37,5	30,92	< 5bar
	65	37	30,92	< 5bar
	60	36,5	30,92	< 5bar
	55	36,1	30,92	< 5bar
	50	35,6	30,92	< 5bar
	45	35,1	30,92	< 5bar
	40	34,7	30,92	< 5bar
	Note:			
	The light green line represents the maximum operation point where we would like to run the plant after trim step.			
	The first two lines in the table contain the results out of "Druckwärmestau" measurements we already have.			
	These done experiments allow us to assume that an GAA content of 30,9 % results in a pressure build up off less than 5 bars to safe the stripping column.			
	Moreover all the printed pairs of DN and solids represents a constant GAA content and can therefore be run safely in the plant			
	- GAA content trip 32% SOL <33% (Trip is still outside of an assumed 10% error of dosing units) - Degree of Neutralization trip 39% SOL >38% - Temperature Lower trip: -6°C Lower SOL: -7°C higher trip 3°C SOL <5°C			

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

Safety Review - BASF-HAZOP			Primary Measures			Process Safety		
Functional Group		Neutralization & Trim Step		FG-No.		Page 5 of 34		
Attachment(s)  Druckwärmestau 45.5 8bar.doc  Druckwärmestau 42.6 5.5bar.doc  Study and calculations of DN100process lab - june 20:  Safety testings in process lab - june 20:  Reaction energy overview.doc  Crystalizationpoints DN100 FG30 33 35.p  Crystalizationpoints DN75 FG38  Premix NaOH_H2O.xls  Consideration Dosage Error for trim  Pressure ant Temp increase.pdf  SIK Rep 03_2790 DN75 SC42,6.pdf  SIK Rep 03_2791 DN 65 SC45,5.pdf  SIK Rep 11_0460 DN39 SC 38.pdf  Bornmuth note 20130624.xps								
Report(s)								
Note(s)								

Column 'S'-Abbreviations: Z = Class A Safety Installation: O = Organizational Measures: Y = Safety Valve/ Rupture Disc: E = Inherently Safe

Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.		Page 6 of 34			
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
Intended Values of the Substances (11X = Chemical Properties 12X = Charging 13X = Physical Properties 14X = Explosion Protection)							
Composition or Concentration - more - less Other Materials	Operating Error Valve/ Equipment Leak Instrumentation Failure						
Premix caustic tank B1002							
- Too high caustic concentration in the tank	Failing ratio of caustic 50% to soft water	Uncontrolled polymerization due to insufficient water to catch heat of neutralization. Risk matrix: S1 x P2 = B risk, SIL3 required	Soft water must present to dilute caustic from 50% to 15% until 22% concentration. SIF UZ-A- U10021 will ensure sufficient water in caustic solution If water is insufficient shutoff HVK H10020 and H10021, H10022, H10023 SIF UZ+A± U10023 will ensure caustic not too more and not too less. If caustic is too much or too less shutoff HVK H10020 and H10021, H10022, H10023 SIF U10028 will ensure deviation soft water/caustic ratio's there always sufficient water to keep solid content in safe range. The max. set point for solid content is limited at 22% Operation range 15% - 22% caustic solids after dilution. ⇨ Dosage ratio NaOH/Soft water for 15% NaOH: 0.432 ⇨ Dosage ratio NaOH/Soft water for 22% NaOH: 0.786 Trip point X t/h; SOL X t/h Response time 30 sec. Start-up overwrite: 30 seconds for ratio. SIF U10028 will stop inline mixing in case ratio deviation or flow rate not in range: - soft water valve HVK±(Z) H10020 and HVK±(Z) H10021 - caustic valve HVK±(Z) H10022 and HVK±(Z) H10023	Z		Define trip points <	

Safety Review - BASF-HAZOP			Primary Measures		Process Safety		
Functional Group			FG-No.		Page 7 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
caustic concentration in the tank	supplier not feasible						
Too low caustic concentration in the tank	Wrong delivery by supplier	Uncontrolled polymerization due to diluted GAA with water is even more unstable Risk Matrix: S1 (runaway) x P4 (wrong delivery and failure of density compensation) = E risk	Check certificate of analysis of supplier Regular audit of supplier. Loading of different caustic qualities is separated at supplier Deviations of density will be detected by density measurement of mass flow meter F10022/10023. Failure will be detected because fine tuning in neutralization require less acid, pH value is out of normal range			Add MFM to measure density online during unloading of caustic Compensate density fluctuation by amount of water (possible in SIL3 ?). If density is significantly out of limits (tbd) an alarm shall be given.	
Neutralization tanks B1011 & B1012							
Different dimer level in GAA	Wrong position of 3 way valve in GAA unloading area	NSRE, only quality issue					
- Too high solid content in tanks	Failing GAA charging amount	Uncontrolled polymerization due to insufficient water to catch heat of neutralization. Risk matrix: S1 x P2 = B risk, SIL3 required	Sufficient soft water must present in monomer solution also too high amounts of acrylic acid must be prevented Neutralization tank#1 SIF UZ-A- U10111 (diluted caustic totalizer tank1) A minimum amount of caustic solution must be available to achieve a set point for solids of at least 38%. Measured by F(Z) 10110/ F(Z)10111 , totalizer FQ(Z) F10111. If minimum amount is not reached, the dosing of GAA HVK±(Z) H10112 and HVK±(Z) H10113 is locked. Minimum amount of caustic to safeguard 95% neutralization is xx kg If right amount in totalizer is reached valves HVK±(Z) H10110 and HVK±(Z) H10111 will close SIF UZ+A+ U10113 (glacial totalizer tank1) A maximum amount of glacial acrylic acid must not exceed a solid content of 35% Normal amount (in DCS control) of GAA is 2200 kg Maximum amount of GAA (FQZ+ in sPLC) to safeguard 35% solids is yy kg	B	Z		

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

Safety Review - BASF-HAZOP			Primary Measures		Process Safety	
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)		RK	S
	Loosing minimum amount of water or caustic via 3 way valve 2 (accidentally open or leaking)		SIF UZ+A+U10113 (glacial totalizer tank1) will close HVK±(Z) H10112 and HVK±(Z) H10113 if maximum amount is reached. Response time of 30 sec. is sufficient. Neutralization tank#2 SIF UZ-A- U10121 (diluted caustic totalizer tank2) A minimum amount of caustic solution must be available to achieve a set point for solids of at least 38%. Measured by F(Z) 10120/ F(Z)10121 , totalizer FQ(Z) F10121. If minimum amount is not reached, the dosing of GAA HVK±(Z) H10122 and HVK±(Z) H10123 is locked. Minimum amount of caustic to safeguard 95% neutralization is xx kg If right amount in totalizer is reached valves HVK±(Z) H10120 and HVK±(Z) H10121 will close SIF UZ+A+ U10123 (glacial totalizer tank2) A maximum amount of glacial acrylic acid must not exceed a solid content of 35%. Normal amount (in DCS control) of GAA is 2200 kg Maximum amount of GAA (FQZ+ in FPLC) to safeguard 35% solids is yy kg SIF UZ+A+U10123 (glacial totalizer tank2) will close: HVK±(Z) H10122 and HVK±(Z) H10123 Trip point xx kg; SOL xx kg Response time 30 sec. end position switch H10115/10125 confirm that valve is in correct position			
						add FDZ+ comparing delta in flow between F(Z)F10115 (upstream of 3 way valve) and F(Z)F10116. Trip point to be defined. FZQ in reactor discharge to compare reactor outlet at the end of reaction with

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
						reactor inlet amount to prove for leakage after each batch in SIL2	
- Too low solid content in tanks	Overdosing of soft water	Overdosing of water is only quality impact	NSR				
- Sequence of dosage	Glacial acrylic acid dosage can start without having caustic/water solution in the tank	Major issue! Pure glacial can be mixed with even more pure glacial AA in trim step and can polymerize afterwards 100% solids => worst case! Risk matrix: S1 x P2 = B risk, SIL3 required for dosing of caustic solution and acrylic acid totalizers Temperature measurement Risk matrix: S2 x P3 = D risk ⇒ High quality monitoring device checked every two years	Sequencer of dosage tank#1 in DCS Some steps are confirmed in SIS Neutralization tank#1 - At the end of previous batch make sure that tank is emptied in SIS (SIL2): 3-way valve is in discharge position (limit switch channel A), and confirm that content has left tank by FZQ- (channel B). SIS shall compare total outlet amount with total inlet amount. If no big deviation to negative side (due to leakage or remaining content in reactor), SIS shall reset all counters to zero. - Reset the flow totalizer of diluted caustic FI(Z) F10110 and FI(Z) F10111 and totalizer of glacial acrylic acid FI(Z) F10112 and FI(Z) F10113 - Open chilled water valves to neutralization tank HVK± H10116 and chilled water valve to heat exchanger HVK± H10117, confirmed by end position switch in S - Three way valve HVK± H10115 has to be in recirculation position (see above 111c less water, less caustic), SIS confirms and gives a feedback signal to DCS - Add the premixed caustic by open on-off valve HVK±(Z) H10110 and HVK±(Z) H10111 and adjust flow rate by FVC F10111-1. - Start circulation pump P1011, minimum circulation flow F(Z) 10115 and F(Z) F10116 is condition for opening GAA valves. If circulation flow is too low, GAA valves HVK H10112/H10113 are locked. - When premix caustic filling near to set point FQZ- then reduce FVC F10111-1 to 50% opening until reached full amount according to formulation then close on-off valve HVK±(Z) H10110 and HVK±(Z) H10111 - Minimum amount auf caustic FQZ- is reached - Wait till premix caustic has cooled down <30°C by monitoring of TIC T10111. TS+ 10110 keep GAA valve HVK±(Z) H10112 and HVK±(Z) H10113 locked if Temperature higher than 30 deg C - Start dosage of glacial acrylic acid and keep temperature always			see above 111c	
						see above 111c	

Column 'S'-Abbreviations: Z = Class A Safety Installation: O = Organizational Measures: Y = Safety Valve/ Rupture Disc: E = Inherently Safe

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s) R
			<40°C by open on-off valve HVK±(Z) H10112 and HVK±(Z) H10113 and adjust flow rate by FVC(Z) F10113-1. Dosing rate control set point of GAA is 100 kg/min. Set point of FZ+ is 120 kg/min ⇒ If the temperature during addition of GAA reach 40 deg C, TS+ 10110 will close GAA valves HVK±(Z) H10112 and HVK±(Z) H10113 ⇒ When acrylic acid reached 95% of full amount according to formulation slow down flow rate to adjust pH in the window 11 until 9 by two pH sensors QIC Q10110 and QIC C10111 ⇒ Verify if extra water for solid correction is needed or not if yes open the valve HVK± H10114 and adjust flow rate by FVC F10114-1 until total amount according to formulation is reached by reading of FQI F10114 ⇒ Batch completed and waiting for transfer to RTB tank by keep always recirculation of monomer via P1011. Chilled water valve to neutralization tank HVK± H10116 will be closed ⇒ Condition to open 3-way valve into direction of release to RTB following conditions must be fulfilled: ○ If RTB tank B1015 reached low level LS- L10150 ○ Temperature TS+ T10110 below 15 deg C ○ GAA valves HVK±(Z) H10112 and HVK±(Z) H10113 closed confirmed by end position switches ○ pH value Q10111/10110 is 9 to 11 Scenarios for interrupting batch operation: ⇒ SIF UZ-A- U10116 will ensure recirculation working by 2 different mass flow FI(Z) F10115 and FI(Z) F10116 ⇒ TS+ T10110 Temperature >40°C during neutralization ⇒ SIF UZ-A- U10111 and SIF UZ+A+ U10113 total amounts of dosing of components are not reached Final check pH and density before pump to RTB vessel Trip point below 9, above 11 Response time xx sec. Neutralization tank 2 ⇒ At the end of previous batch make sure that tank is emptied in SIS (SIL2); 3-way valve is in discharge position /limit switch			add S- add trip point add S+- to pH meter to keep valve close in case of PH deviation add SIF for FDZ+ leakage trip, see above 111c see above 111c

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe



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Safety Review - BASF-HAZOP

Primary Measures

Process Safety

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
			channel A), and confirm that content has left tank by FZQ- (channel B). SIS shall compare total outlet amount with total inlet amount. If no big deviation to negative side (due to leakage or remaining content in reactor), SIS shall reset all counters to zero. ⇒ Reset the flow totalizer of diluted caustic FI(Z) F10120 and FI(Z) F10121 and totalizer of glacial acrylic acid FI(Z) F10122 and FI(Z) F10123 ⇒ Open chilled water valves to neutralization tank HVK± H10126 and chilled water valve to heat exchanger HVK± H10127 ⇒ Three way valve HVK± H10115 has to be in recirculation position (see above 111c less water, less caustic), SIS confirms and gives a feedback signal to DCS ⇒ Add the premixed caustic by open on-off valve HVK±(Z) H10120 and HVK±(Z) H10121 and adjust flow rate by FVC(Z) F10121-1 ⇒ Start circulation pump P1012. Minimum circulation flow F(Z) 10125 and F(Z)F10126 is condition for opening GAA valves. If circulation flow is too low, GAA valves HVK H10122/H10123 are locked. ⇒ When premix caustic filling near to set point then reduce FVC (Z) F10121-1 to 50% opening until reached full amount according to formulation then close on-off valve HVK±(Z) H10120 and HVK±(Z) H10121 ⇒ Minimum amount auf caustic FQZ- is reached ⇒ Wait till premix caustic has cooled down <30°C by monitoring of TIC T10121. TS+ 10120 keep GAA valve HVK±(Z) H10122 and HVK±(Z) H10123 locked if Temperature higher than 30 deg C ⇒ Start dosage of glacial acrylic acid and keep temperature always <40°C by open on-off valve HVK±(Z) H10122 and HVK±(Z) H10123 and adjust flow rate by FVC(Z) F10123-1. Dosing rate control set point of GAA is 100 kg/min. Set point of FZ+ is 120 kg/min ⇒ If the temperature during addition of GAA reach 40 deg C, TS+ 10120 will close GAA valves HVK±(Z) H10122 and HVK±(Z) H10123 ⇒ When acrylic acid reached 95% of full amount according to formulation slow down flow rate to adjust pH in the window 11 – 9 by two pH sensors QIC Q10120 and QIC C10121			see above 111c	

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe



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Safety Review - BASF-HAZOP

Primary Measures

Process Safety

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
			⇒ Verify if extra water for solid correction is needed or not if yes open the valve HVK± H10124 and adjust flow rate by FVC F10124-1 until total amount according to formulation is reached by reading of FQI F10124 ⇒ Batch completed and waiting for transfer to RTB tank by keep always recirculation of monomer P1011 always running in recirculation. Chilled water valve to neutralization tank HVK± H10126 will be closed ⇒ Condition to open 3-way valve into direction of release to RTB following conditions must be fulfilled: ○ If RTB tank B1015 reached low level LS- L10150 ○ Temperature TS+ T10120 below 15 deg C ○ GAA valves HVK±(Z) H10122 and HVK±(Z) H10123 closed confirmed by end position switches ○ pH value Q10121/10120 is 9 to 11 Scenarios for interrupting batch operation: ⇒ SIF UZ-A- U10126 will ensure recirculation working by 2 different mass flow FI(Z) F10125 and FI(Z) F10126 ⇒ TS+ T10110 Temperature >40°C during neutralization ⇒ SIF UZ-A- U10121 and SIF UZ+A+ U10123 total amounts of dosing of components are not reached Final check pH and density before pump to RTB vessel Trip point below 9, above 11 Response time xx sec.			add S- add trip point add S+- to pH meter to keep valve close in case of PH deviation add SIF for FDZ+ leakage trip, see above 111c	
f	- Too high degree of neutralization		NSRE				
g	- Too low degree of neutralization	Failing GAA charging amount	Uncontrolled polymerization due to insufficient water to catch heat of neutralization. Both neutralization tanks, close pipe, heat exchanger which can result in GAA amounts > 33%. Risk matrix: S2 x P1 = B risk, SIL3 required	Soft water must present and also too high amounts of acrylic acid must be prevented. Minimum amount of caustic must be present to slow down a potential reaction ⇒ See above 111-c	B	Z	
RTB Tank B1015		Composition similar to	See above c-g				

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
	neutralization tanks – safety measurements already considered in neutralization tanks therefore no additional action for RTB tank needed						
j	Pre-mix Glacial acrylic acid with crosslinker – R1031 static mixer						
	- Too high concentration of crosslinker in acrylic acid	Crosslinker flow only without any additional flow of acrylic acid and DN100 solution ⇒ Very high amounts of crosslinker as a result. NSRE, only quality issue	Even crosslinker can dissolve in glacial acrylic acid without hazard Ratio control in DCS: Master is monomer DN100 flow rate, crosslinker flow rate is slave If ratio FFICA+-S+- F10321 of DN100 flow FIC(Z)-A- F10321 and Crosslinker flow FIC(Z)-A- F10410 is out of range all dosages stops by closing on-off valves below in S-quality: - monomer valve HVK±(Z) H10320 and HVK±(Z) H10321 - GAA trim valve HVK±(Z) H10310 and HVK±(Z) H10311 - crosslinker valve HVK±H10410 and stop pump P1041 - photo initiator HVK±H10510 and stop pump P1051 - switch to monomer recirculation HVM±K(Z) H10150				
k	- Too low concentration of crosslinker in acrylic acid	Low amounts of crosslinker as a result. NSRE, only quality issue	See above 111j				
l	Trim step R1032						
	- Too low degree of neutralization (flow GAA high)	No flow or too low flow of DN100 monomer solution due to malfunction of valve or flowcontrol	Maximum risk due to the matter of fact that pure glacial acrylic acid can polymerize in reactor Risk matrix: S2 x P1 = B risk, SIL3 required Control system: Ratio of DN100 monomer (master) and Glacial acrylic acid (slave) SIF UZ+A+ U10311 (ratio control for trim step) If ratio FFICA(Z) – of DN100 flow F10320 and F10321 and GAA trim flow F10310, F10311 is too low the following dosages are closed in SIL3 quality: - GAA trim valve HVK±(Z) H10310 and HVK±(Z) H10311 And following valves are closed in S-quality: - monomer valve HVK±(Z) H10320 and HVK±(Z) H10321 - crosslinker valve HVK±H10410 and stop pump P1041	B	Z	add Z to ratio	

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
			- photo initiator HVK±H10510 and stop pump P1051 - switch to monomer recirculation HVM±K(Z) H10150 Normal ratio: 528 kg/h / 10888 kg/h = 0.048 Trip point ratio: 728 kg/h / 10888 kg/h = 0.066 over more than 1 min. Response time 30 sec. Start-up overwrite: 60 seconds.			clarify inaccuracy of instruments and consequence for ratio	
m	- Too high degree of neutralisation	NSRE					
n	- Too high solid content	No flow or too low flow of DN100 monomer solution Refer to ratio wrong 111 l	Maximum risk due to the matter of fact that pure glacial acrylic acid can polymerize! Risk matrix: S2 x P1 = B risk, SIL3 required	SIF UZ+A+ U10311 (ratio control for trim step) Refer to ratio wrong 111 l	B	Z	
m	- Too low solid content	NSRE					
o	Photo initiator addition						
	- Too high concentration of photo initiator	NSRE	Ratio control in DCS: Master is monomer DN100 flow rate, photoinitiator flow rate is slave If ratio FFICA+-S+- F10321 of DN100 flow FIC(Z)-A- F10321 and Photoinitiator flow F10511 is out of range all dosages stops by closing on-off valves below in S-quality: - monomer valve HVK±(Z) H10320 and HVK±(Z) H10321 - GAA trim valve HVK±(Z) H10310 and HVK±(Z) H10311 - crosslinker valve HVK±H10410 and stop pump P1041 - photo initiator HVK±H10510 and stop pump P1051 - switch to monomer recirculation HVM±K(Z) H10150				
p	- Too low concentration of photo initiator	NSRE	See 111o				
121	Mass Flow rate - more - less	Instrumentation Failure					

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S Open Point(s) R
Premix caustic tank B1002					
-					
- Caustic 50% flow too high	Failure of caustic flowcontrol	Too high flowrate through the heat exchanger results in too high temperature of the mixing solution – more over it could cause leaching of iron from stainless steel (happens at approx. 60°C)			Add orifice to limit flow to 3800 kg/h
- Water flowrate too high	Failure of water mass flow	NSRE			
- Water flowrate too low	Failure of water mass flow	NSRE			
Neutralization tanks B1011 & B1012					
- Circulation stream in vessel too high	Failure of recirculation mass flow tank#1 or Failure of recirculation mass flow tank#2	NSRE			
- Circulation stream in vessel too low	Failure of recirculation mass flow tank#1 or Failure of recirculation mass flow tank#2	Risk for hot spots can cause polymerization and also lead to precipitation which acts as seeds for polymerization and also causes blockage in the pipes Risk matrix: S1 x P2 = B risk => SIL3 required	Neutralization tank#1 SIF UZ-A- U10116 (losses of recirculation flow) If recirculation fail then close dosing valve of GAA HVKz(Z) H10112 and HVKz(Z) H10113 and premix caustic valves HVKz(Z) H10110 and HVKz(Z) H10111 to neutralization tank#1 Trip point tbd considering capacity of heat exchanger and heat to be removed Response time 10 sec. Start-up overwrite: 5 seconds.	B	Z
- Flow rate of acrylic acid too high	Failure of acrylic acid mass flow tank#1 Failure of acrylic acid mass flow tank#2	Too high flowrate through the heat exchanger W10111 results in too high temperature of the mixing solution – too high temperature of the solution could cause polymerization.	FIC(Z)+S+A+ F10113 SIF UZ+A+ U10113 (high flowrate) If GAA flow too high close dosing valve HVKz(Z) H10112 and HVKz(Z) H10113 for GAA.	B	Z

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe



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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S Open Point(s) R
		Even if polymerization happens the system will be intrinsically safe due to DN100 solution with only 36% solids max. Uncontrolled polymerization can happen for very high flow of GAA due to recirculation stream will be not sufficient any longer. ⇒ Potential for hot spots and also areas with too high solids Risk matrix: S1 x P2 = B risk => SIL3 required	Trip point 120 kg/min or calculate it considering capacity of heat exchanger and heat to be removed Response time 10 sec. Start-up overwrite: n.a.		
- Flow of acrylic acid too low	Failure of acrylic acid mass flow tank#1 Failure of acrylic acid mass flow tank#2	NSRE			
- Caustic 20% flow too high	Failure of premixed caustic mass flow tank#1 Failure of premixed caustic mass flow tank#2	NSRE			
- Caustic 20% flow too low	Failure of premixed caustic mass flow tank#1 Failure of premixed caustic mass flow tank#2	NSRE			
- Extra water for solids trim too high	Failure of extra water mass flow FQ F10114	NSRE			
- Extra water for solids trim too low	Failure of extra water mass flow FQ F10114	NSRE	NSR		
Pure Glacial acrylic acid mixed with crosslinker – R1031 static mixer					
- Too high crosslinker flow	Failure of crosslinker mass flow control	NSRE			
- Too high acrylic acid	Failure of GAA mass flow control	Wrong ratio of GAA and	See wrong ratio of GAA and monomer see above		

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe



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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
flow		monomer, see above Potential overflow of stripping column					
- Too low crosslinker flow	Failure of crosslinker mass flow control	NSRE					
- Too low acrylic acid flow	Failure of acrylic acid flow control	NSRE					
-							
-							
Trim step R1032 to mix DN100% monomer							
- Too high acrylic acid / crosslinker flow	Failure of monomer flow measurement See also 132 "pressure"	A two high DN100 monomer flow can overflow the stripping column Uncontrolled polymerisation in polybelt, release of acrylic acid Risk matrix: S1 x P2 = B risk => SIL3	SIF UZ-A- U10321 (high flow FZ+) If GAA flow is too high close GAA trim valve HVK±(Z) H10310 and HVK±(Z) H10311 in SIL3 The following valves are to be closed in S-quality:: - monomer valve HVK±(Z) H10320 and HVK±(Z) H10321 - crosslinker valve HVK±H10410 - photo initiator HVK± H10510 and stop pump P1051 - monomer recirculation HVM±K(Z) H10150 Normal flow rate: 528 kg/h Trip point flow rate : 728 kg/h over more than 1 min. Response time 30 sec. Start-up overwrite: 60 seconds.	B	Z		
- Too low acrylic acid / crosslinker flow	NSRE						
- Too high monomer flow	Failure of monomer flow control	Refer to Overflowing of K1150					
- Too low monomer flow	Failure of monomer flow control	Wrong ration of GAA/monomer, see above					
Photo initiator addition							

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
- Too high / too low photo initiator flow	Failure of photoinitiator flow control	NSRE					
Temperature - more - less	Operating Error Instrumentation Failure Utility Loss Chem. Reaction, Decomposition		Operating and Design Temperature: See Table on Page 1 Pressure Increase See 132 Heating/ Cooling, Summer/ Winter Operation: See 231/232				
Premix caustic tank B1002							
- Too high temperature in tank	Failure of temperature control TICS+ T10020	Heat of dilution cause leaching of iron from stainless steel if temperature of caustic > 60°C	TIS+A+ T10021 (temperature measurement in the tank). Trip at 45 deg C If temperature of caustic solution in the tank too high then close dosing valve HVK± (Z)H10022 and HVK±(Z) H10023 (caustic valve) and HVK± (Z)H10020 and HVK±(Z) H10021 (water valve) in S-quality				
- Too low temperature in tank	Failure of temperature measurement	NSRE					
Neutralization tanks B1011 & B1012							
- Too high temperature in tank	Failure of temperature control T10111	Uncontrolled polymerization due to too high temperature, neutralization tanks, close pipe, heat exchanger which can result pressure < 5 bar at solid 38%. Pipe design at 10 bar Risk matrix: S1 x P2 = B risk => SIL3 required	To prevent uncontrolled polymerization: Ensure total amount of GAA dosing to neutralization tanks by mass flow SIL3, see above TS+ T10110 (temp switch high tank#1) and TS+ T10120 (temp switch high tank#2) will be installed with high quality monitoring device checked every year. Requirement to start GAA feed HVK±(Z) H10112 and HVK±(Z) 10113 to neutralization tank is that T10110 (B1011) and T10120 (B1012) is below 30 deg C. If during neutralization temperature exceeds to 40 deg GAA feed HVK±(Z) H10112 and HVK±(Z) H10113 and HVK±(Z) H10122 for B1011 and HVK±(Z) H1013 for B1012 will be closed.	B	Z		
- Too low temperature in Tank	Failure of temperature control T10111	NSRE					
Trim step R1032							
- Too high temperature in trim step	Failure of temperature control TIC T10160 or heat exchanger malfunction or loss of cooling	Uncontrolled polymerization due to higher T0 (starting temperature of polymerisation) will make Tmax above 100°C which can generate hot steam, overpressure	Ensure total amount of GAA dosing to trim step by mass flow in SIL3 quality Due to totalizer and mass flow will be implemented in SIL3,				

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
		and acrylic acid vapor from reactor belt Risk Matrix: S3 (one or more LTI) x P1 (reliability of T-control) = E. Additionally in 90% or the time no operator is present	TS+ T10400 (temp switch after trim step) will be installed with high quality monitoring device checked every two years	E			
f	- Too low temperature	Failure of temperature control	Precipitation of monomer solution which act as a seed for polymerization.				
	Stripping column K1150						
	- Too high temperature in column	Failure of T10400 or heat exchanger malfunction or loss of cooling	Slightly higher temperature but NSRE				
	Too low temperature in column	Failure of T10400, excessive cooling below lower design T of column. Column gets brittle and loses mechanical strengths, potential rupture in case of higher pressure				Check lower design T	
132	Pressure - more - less		Operating and Design Pressure: See Table on Page 1				
a	Premix caustic tank B1002						
	- Too high pressure in tank	Failure of heat exchanger W1002	Only thermal expansion due to heat of solubility can happen Assumption: Temp. NaOH: 30°C Temp. soft water: 30°C Final mixture NaOH 20%: 54°C (proved via lab experiment)				
b	- Too low pressure in tank	Failure of the pump P1002	If B1002 lacks of a vent vessel will get underpressure Therefore "goose neck" venting installed on top of the vessel Risk matrix: S3 x P3 = F risk				
	Neutralization tanks R1011 &						

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
c	R1012						
	- Too high pressure in tank	Uncontrolled polymerization due to insufficient water to catch heat of neutralization. Internal leakage of W1011/ W1012	Uncontrolled polymerization due to insufficient water amount is prevented in SIL3 (see above). Due to done worst case calculation a thermal increase to approx. 80°C without cooling can be possible. But even then a polymerization is that kind of slow due to high DN and low that in principle no additional temperature peak could be measured. (As long as initiators kept away from the liquid) Therefore even in a worst case situation no steam developed is expected (As long as initiators kept away from the liquid)			Add breathervalue	
d	- Too low pressure in Tank	Pump P1011 / P1012 are running but no air intake from AA vent e.g. because handvalve is closed	Vessel will be damaged and loose content			Remove handvalve in offgas line, add breathervalue	
	RTB B1015						
	Overpressure	due to internal leakage of heat exchanger W1014 or W1016	Overfill and overpressure. For W1014 and W1016 100 mm2 leakage to be considered for design of pressure relief			Remove handvalve in offgas line, add breathervalue	
	-						
e	Stripping column K1150						
	- Too high pressure in column	Uncontrolled polymerization or blocked vent	Overpressure in the column can cause damage				

Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 21 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
	Plant air 10 barg		Breather valve 5 barg Y11500, F(Z) orifice 1505 to limit plant air and nitrogen			relocate PSV to on top of vessel with minimum distance and add line for plant air purging of PSV nozzle	
	Internal leakage W1040	For W1040 100 mm2 leakage to be considered for design of pressure relief					
	Overfilling see level high						
f	- Too low pressure in column	Venting blocked while pump P1150 is discharging	If Stripping column K1150 lacks of a vent vessel will get underpressure	Vent opening installed on top of the column and purged with air Breather 2valve			
	Heat Exchangers, W1002, W1011, W1012, W1014, W1016, W1040, Also chilled water jacket of neutralization tanks B1011 and B1012						
h	- Too high pressure in heat exchangers	Blocked in valves on the chill water system side	Thermal expansion	On every heat exchanger a pressure relief valve is installed: Y10112, Y10122, Y10140, Y10160, Y10400, Y10110, Y10120, Y10020	Y		
i	- Too low pressure in heat exchangers	No cause found					
133	Level - more - less						
	NaOH 50% storage tank B1001	Not in the scope of the project					
a	- Level too high in caustic tank	Failure of level indicator LI +- L10012	Overfilling of the tank	LS++ L10010 B1001 tuning fork regarding overfilling installed, Overfilling outlet on the top of tank, also a secondary containment is present which can hold more than the tank capacity			
b	- Level too low in caustic tank	Failure of level indicator LI +- L10012	Pump P1001 can get damaged due to cavitation	LS - - B1001 indicator regarding low level of tank installed.			
	Water storage tank B1003	Not in the scope of the project					

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 22 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
c	- Level too high in water tank	Failure of level indicator LI B1003	Overfilling of the tank Risk matrix: S4 x P1 = E risk	LS++ B1003 indicator regarding overfilling installed, Overfilling outlet on the top of tank, also a secondary containment is present which can hold more than the tank capacity	E		
d	- Level too low in water tank	Failure of level indicator LS B1003	Pump P1003 can get damaged due to cavitation	LS - - B1003 indicator regarding low level of tank installed.			
	For Premix caustic tank B1002 and also for Neutralization tanks B1011 / B1012 the same conditions as 133 a-d	Overdosing or overfilling by extra water or overfilling because vessel was not emptied before starting new batch. Failure of level indicator L10111/ L10121.		LS+10110 / L10120 close feed valves in B1011: caustic HVK H10110/10111, GAA HVK H10112/H10113, extra water HVK H10114 Valves in B1012 caustic HVK H10120/10121, GAA HVK H10122/H10123, extra water HVK H10124 safeguard that tank is empty before starting next batch: see above ...			
	Crosslinker storage tank B1041	Not in the scope of the project					
e	- Level too high in crosslinker tank	Failure of level indicator LI 10411	Overfilling of the tank Risk matrix: S4 x P1 = E risk	LS++ L10410 indicator regarding overfilling installed, Overfilling outlet on the top of tank, also a secondary containment is present which can hold more than the tank capacity	E		
f	- Level too low in crosslinker tank		NSRE				
	Photo initiator mix tank B1051						
g	- Level too high in photo initiator tank	Failure of loadcells W10510	Overfilling of the tank in principle not possible due to the filling of the tank is done manually	WI+ Overfilling outlet on the top of tank, also a secondary containment is present which can hold more than the tank capacity			
h	- Level too low in photo initiator tank		NSRE				
	RTB tank B1015						
i	- Level too high in RTB tank	Failure of level tuning fork LI 10151	Overfilling of the tank Risk matrix: S4 x P1 = E risk	LS++ 10150 indicator regarding overfilling installed, Overfilling outlet on the top of tank, also a secondary containment is present which can hold more than the tank capacity	E		
j	- Level too low in RTB tank	Failure of level indicator LS 10151	Pump P1015 can get damaged due to cavitation	Low flow of P1115 can detect low level in tank B1015.			
	Stripping column K1150						
k	- Level too high in stripping column	Failure of level indicator LI 1150	Overfilling of the column Risk matrix: S4 x P1 = E risk	LS++ L11501 indicator regarding overfilling installed, Overfilling outlet on the top of column installed, also a secondary containment is present which can hold more than the columns capacity	E		
l	- Level too low in stripping column	Failure of level indicator LS K1150	NSRE	FS - - indicator regarding low flow of column installed.			

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 23 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
134 Viscosity / Density more/ less	Chemical Change Concentration Change Temperature Change Phase Change	Foam Formation Flow Resistance increase/ decrease Deposits / Sediments Less Stirring Stirrer Failure	Indirectly recognized from various intended values Amount, Temperature, Pressure, Level: See 121,131-133				
	Unwanted polymerisation in any part of the process will lead to solids	Plugging and pump stops. Operational issue, NSRE other than described above					
135 Foaming Phase Separation Problems	Bad Phase Separation Phase Reversion						
	No deviation in this functional group						
141 Explosion Limits Concentration between upper and lower explosion limits O ₂ -Concentration above limit concentration	Bad or No Inertization Air Intrusion into Vacuum (Leakage)	Explosive Atmosphere					
	no change of EX-classification for this functional group	According EPD the atmosphere inside neutralization tank, RTB, K1150 is nEX					
142 Ignition Sources Local Ignition Temperature or Ignition Energy reached	Electrostatic Discharges Chemical Ignition (hot spot) Mechanical Damage of Rotating Equipment (Friction) Flashback/Combustion Hot Surfaces Adiabatic Compression Dry Running of Pump	Ignition Explosion Equipment Damage/Rupture					

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 24 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
No change for this functional group	Dry running of pumps is prevented by FS- or LS- , see pump protection						

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 25 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
Intended Function of the Equipment (21X = Tightness 22X = Mixing / Separation 23X = Heat Transfer 24X = Supply)							
211 Equipment Leakage - external - internal	Operating Error Construction/Installation Error Welding Faults Bad or Wrong Material Corrosion Erosion Vibration Mechanical Stress Thermal Cycling						
211a Equipment Leakage - external		Personnel Endangering Emission Environment Endangering Emission Fire Explosion					
B1001			Secondary containment designed to hold the volume of biggest tank in the dike, regular inspection by operator				
B1002			Secondary containment hold the volume of biggest tank in the dike, regular inspection by operator				
B1011/B1011			Secondary containment hold the volume of one batch in the building, regular inspection by operator				
RTB			Secondary containment hold the volume of one batch in the building, regular inspection by operator				
K-1150			Secondary containment hold the volume of one batch in the building, regular inspection by operator				
211b Equipment Leakage - internal	Heat Exchanger Leaking Internally	Water flows into Product Product flows into Water Pressure Breakthrough					
Heat exchanger internal leakage, refer to pressure high							
212 Pipe/ Flange(s) Leakage	See 211	See 211					
GAA pipe service			Teflon gaskets, flange protection			Check if comply with BASF pipe service index for AA	



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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 26 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
Caustic pipe service			Teflon gaskets, flange protection				
213 Valves/Fittings Leakage - external - internal	See 211	See 211					
213a Valves/Fittings Leakage - external							
213b Valves/Fittings Leakage - internal							
214 Pump Leakage	See 211	See 211					
			Pump with double mechanical seal (P1001, P1008, P1115, P1002) or Magnetic driven pump (P1011, P1012)			Check the elastomer for mechanical seal if it is compatible to GAA	
215 Agitator/ Mixer Leakage	See 211	See 211					
Only static mixer							
221 Agitator/ Mixer - failure - running too slow							
Only static mixer	Insufficient flow, improper mixture, create hotspots and		Minimum flow of monomer is safeguarded by FZ-				

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 27 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
	runaway polymerization downstream						
222	Pump Failure <i>Operating Mistake (Closed Valve(s)) Instrumentation Failure Mechanical Damage Loss of Electrical Power</i>	<i>No supply Overfilling</i>	<i>Flow Rate: See 121 Reverse Flow: See 241</i>				
	P1011, P1012 failure during or before neutralisation	Insufficient cooling, insufficient mixing, potential runaway polymerization	FZ- interlock feeds, see above under ...				
	P1011, P1012 failure during transfer to RTB	Production interrupted but NSRE					
	P1115 failure during circulation cooling	Production interrupted but NSRE					
	P1115 failure during transfer to R1032	Wrong ratio of monomer and GAA in trim step, see above	FZ- will interlock GAA feed on wrong ratio				
	P1150	Production interrupted but NSRE					
	P1041 dosing pump X-Linker	See low flow x-linker, NSRE					
	P1008 GAA to trim step	See low flow GAA to trim step, NSRE					
	P1000 GAA pump to neutralization	See low flow GAA to neutralization, NSRE					
	P1001 Caustic to Premix tank	Wrong ration of caustic and water, see above	FZ- will interlock caustic and water feed to premix tank, see above				
	P1003, water to premix tank	See low flow water to premix tank, not sufficient water in neutralisation	FQZ- will trip/ interlock neutralisation, see above				
223	Separation Vessel Incomplete Phase Separation	<i>Mixing due to high flow rate Effluent Weir damaged Operating Mistakes Instrumentation Failure Chemical Influences Emulsion Formation Phase Inversion</i>	<i>Phase Breakthrough</i>	<i>Amount, Temperature, Pressure, Level: See 121,131-133</i>			

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Safety Review - BASF-HAZOP		Primary Measures			Process Safety		
Functional Group		FG-No.			Page 28 of 34		
Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
NA							
231	Cooling - less/ loss of - more	<i>Utility Loss Operating mistakes Instrumentation Failure Fouling of Surfaces</i> <i>Freezing</i>	<i>No/Less Condensation Temperature Increase Pressure Increase</i> <i>Expansion, Equipment Rupture</i>	<i>Temperature: See 131 Pressure: See 132</i>			
	More cooling in W1016 and W1040: Freezing of DN100 and / or finished monomer solution	Low temperature of monomer solution in general	Process dependable we need to cool down monomer solution to 0°C and perhaps even little below due to the matter of fact we are dealing with concentrated salt solutions it might be possible to drop below solubility limit of the salt solution and therefore have to face precipitation. Solids can act as seed for polymerization.	According to crystalizing report number 13N00720, the monomer solution DN75% start freezing at -7 °c and monomer DN100% start freezing far below -20 °c TS -- T10400 or TS - - T10160 shut off reactor by switching 3-valve to circulation when temperature of monomer solution are cooled with glycol chiller system to -6°C (on water side controlled at -5°C)		TS- shall close valves in cooling medium HVK H10160 and H10400	
	More cooling in W1002	Low temperature in caustic premix	NSRE and no cause found, lowest CW temperature in Thailand is about 18 deg C				
	More cooling in W1011 and W1012	Control failure in chiller, lowest possible temperature of chilled water is freezing temp of water	Low temperature is desired, NSRE				
	Less cooling	Refer to temperature high					
232	Heating - less/ loss of - more	<i>Utility Loss Operating Mistakes Instrumentation Failure Fouling of Surfaces Mechanical Damage</i> <i>Instrumentation Failure</i>	<i>No/Less Heating Less/Loss of Evaporation Temperature Decrease</i> <i>Overheating, Equipment Rupture</i>	<i>Temperature: See 131 Pressure: See 132</i>			
NA							
241	Reverse Flow	Pump Failure	Overpressure on Suction Side	Mass Flow: See 121			

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
	Loss of Electrical Power Supply Instrumentation Failure	Mechanical Damage Overfilling	Pump Failure: See 222				
Caustic 50% backflow or mallow of water to caustic tank	Failure of pump P1001	Backflow from premix caustic tank is possible because discharge via dip pipe Mal flow of water to caustic storage tank can happen. Wrong concentration of caustic in tank. Will jeopardize ration calculation, potentially leading to hazardous mixture Risk matrix: P1 x S1 = B risk → SIL3 back flow protection required	Backflow protection in SIL3 by redundant FZ-. F10022/ 10023 close HVK±(Z) H10022 and HVK±(Z) H10023	B	Z		
Back flow of caustic premix into softwater tank B1003 or mallow of caustic 50% into softwater storage tank	Failure of pump P1003	Will jeopardize ration calculation, potentially leading to hazardous mixture because minimum amount of water is a mixture of water and caustic with a different heat capacity and insufficient water content Risk matrix: P1 x S1 = B risk SIL3 back flow protection required furthermore contamination of soft water which can cause long term corrosion	Backflow protection in SIL3 by redundant FZ-. F10020/ 10021 close HVK±(Z) H10020 and HVK±(Z) H10021	B	Z		
Backflow of neutralized monomer from Tank B1011 or B1012 to B1002	Failure of pump P1002		Charging from top, no dip pipe. Backflow only possible in case of overfilling. Overfilling prevented by LS+. Overfill line			Delete handvalve in overfill line	
Backflow of neutralized monomer from Tank B1011 or B1012 to B1000	Failure of pump P1000	Contamination of GAA in tank could cause uncontrolled polymerization. Risk matrix: S1 x P2 = B risk => SIL3 required	Charging from top, no dip pipe. Backflow only possible in case of overfilling. Overfilling prevented by LS+. Overfill line Backflow protection in SIL3 by redundant FZ-. F10112/ 10113 close HVK±(Z) H10112 and HVK±(Z) H10113 and redundant FZ-. F10122/ 10123 close HVK±(Z) H10122 and HVK±(Z) H10123	B	Z	Delete handvalve in overfill line	
Backflow of neutralized	Both 3 way valve in discharge	Overfill of receiving tank. Other	checkvalves			Interlock the two 3-	

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
monomer from Tank B1011 to B1012 or vice versa	position	than that NSRE				way valve so that if one 3 way valve is in discharge mode, the other one is in circulation position	
Backflow from RTB to Tank B1011 or B1012	Failure of pump P1011 or 1012	Overfill of receiving tank. Other than that NSRE	Charging from top, no dip pipe. Backflow only possible in case of overfilling. Overfilling prevented by LS+				
Back flow of crosslinker or monomer into GAA storage tank	Failure of pump P1008	Contamination of GAA in tank could cause uncontrolled polymerization. Risk matrix: S1 x P2 = B risk => SIL3 required	Backflow protection in SIL3 by redundant FZ-. F10310/ 10311 close HVK±(Z) H10310 and HVK±(Z) H10311 Required response time max. 3 sec.until valve closed. Worst case is then backflow of 18 kg in 3 sec. which will not reach the tank. Trip point is low positive flow Delay for startup only 10 sec.	B	Z	Relocate flowmeter downstream of blockvalves. Relocate both HVK near to circulation line. Design pipe length downstream of HVK near GAA circulation up to tie in point at static mixture big enough that it can hold backflow volume of at least 40 kg	
Backflow of GAA to crosslinker tank	Failure pump P1041	Back flow of GAA into crosslinker storage tank. X-Linker doesn't react with GAA. Potential overfilling but other than that NSRE	Check valve. Combination of check valve and dosing pump limits the amount of backflow. FS- F10410 close one block valve HVK H10410			Second flowmeter and second blockvalve can be deleted	
Back flow of trimmed monomer solution and photo initiator and / or GAA into RTB	Failure of pump P1115	Contamination in RTB tank could cause uncontrolled polymerisation. Risk matrix: S1 x P2 = B risk => SIL3 required	Backflow protection in SIL3 by redundant FZ-. F10320/ 10321 close HVK±(Z) H10320 and HVK±(Z) H10321 Required response time max. 30 sec.until valve closed. Trip point is low positive flow Delay for startup only 10 sec.	B	Z		
Backflow of trimmed monomer into photoinitiator storage tank possible	Failure of pump P1052	Contamination of trimmed monomer into photoinitiator tank No uncontrolled polymerisation is expected because initiator is inactive without UV light.	Checkvalve. Combination of checkvalve and dosing pump limits the amount of backflow. FS- F10510 close one blockvalve HVK H10510	E		Second flowmeter and second blockvalve can be deleted	

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety			
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
		Overfilling and rupture of tank Risk matrix: S3 x P2 = E risk => monitoring function is required					
Backflow of trimmed monomer from poly belt to K1150	Failure of pump P1150	Overfilling and overpressure of K1150	Physically not possible, solution is sprayed on open belt				
251	Different Operating Condition						
251a	- Start Up of continuous trim step : First switch 3 way valve of RTB tank and get stable flow of monomer. After that open GAA flow to static mixer						
	Wrong ratio	See above under ...					
251b	- Shut Down: close GAA and additives together first, then switch monomer to circulation						
251c	- Emptying, Draining						
	Empty RTB		Run pump until FS- trip pump				
251d	- Flushing/Cleaning						
	Flushing of pure water in neutralization tanks run through run-to-belt tank, heat	Freezing by glycol chiller in heat exchangers Brittle of heat exchanger's gasket, piping's gasket	All chilled water on-off valves must be closed • HVK± H10400 Glycol on-off valve to heat exchanger • W1040				

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety			
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
exchanger, stripping column			• HVK± H10160 Glycol on-off valve to heat exchanger W1016 • HVK± H10116 Chilled water to neutralization tank#1 • HVK± H10126 Chilled water to neutralization tank#1 • HVK± H10117 Chilled water to heat exchanger W1011 • HVK± H10127 Chilled water to heat exchanger W1012 Define 'flushing' mode in sPLC to add only extra water in neutralization tanks. Some SIS functions must be bypassed. The flush mode is activated by key switch. Key is only accessible for dedicated person. Flush mode is time limited for 1 h. Additional organizational measures must be in place in order to reactivate the SIS before start operation. Ratio control GAA/Monomer to be bypassed during flushing Activities for flushing: • mass flow FI F10114 control valve FVC F10114-1 and on-off valve HVK± H10114 • recirculation pump P1011 and P1012 and heat exchanger W1011 and W1012 • Three ways valves HVK± H10115 and HVK± H10125 • Run-to-belt tank B1015 and pump P1115 • Monomer via FI(Z) F10320, FI(Z) F10321, FVC(Z) F10321-1, HVK±(Z) H10320, HVK±(Z) H10321 • Heat exchanger W1040 and stripping column K1150				
251e	- Loss of Utilities						
	-- Steam						
	-- Condensate						
	-- Cooling water	Failure of cooling fan, or pump failure	Loss of cooling for dilution of caustic.				
			TICS+ T10020 after static mixer R1002 Trip point 60°C to close caustic valve HVK± H10022 and HVK± H10023 and closing water valve HVK± H10020 and HVK± H10021 TIS+A+ in premix caustic tank B1002: Trip point 45°C				

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
Chilled water	Compressor or pump failure	Not possible to cool down neutralization, RTB tank. Uncontrolled polymerization.	Stop neutralization dosing if TS++ exceed trip point by closing caustic valve in neutralization tank HVK±(Z) H10110 and HVK±(Z) H10111 in S-quality Operational temperature in the chilled water 6°C circuit. TS+ T10180 (Trip point: 10°C) neutralization will be stopped by close dosing valves below: Neutralization tank#1 HVK±(Z) H10110 and HVK±(Z) H10111 and acrylic acid dosing valve HVK±(Z) H10112 and HVK±(Z) H10113 HVK±H10115 three ways valve switch to recirculation P1011 keep running to avoid hot spots Neutralization tank#2 HVK±(Z) H10120 and HVK±(Z) H10121 and acrylic acid dosing valve HVK±(Z) H10122 and HVK±(Z) H10123 P1012 keep running to avoid hot spot If the temperature in Neutralization tank exceeds 40 deg C, stop dosing GAA (see temperature high)				
Chilled water ex glycol chiller	Compressor or pump failure	Not possible to cool down glycol chiller to get monomer solution of 0°C	Operational temperature in the glycol chilled water is 0°C. Alarm at 3°C. Trip point TS+ T10400 at 5°C will stop process by closing valves in S-quality: - monomer valve HVK±(Z) H10320 and HVK±(Z) H10321 - GAA trim valve HVK±(Z) H10310 and HVK±(Z) H10311 - crosslinker valve HVK±(Z) H10410 and stop pump P1041 - photo initiator HVK±(Z) H10510 and stop pump P1051 3way valve is open for monomer recirculation HVM±K(Z) H10150				
-- Nitrogen	Storage of liquid nitrogen is running out	No oxygen removal for monomer solution, NSRE					
-- Plant air, instrument air	Compressor failure	All control valve failure will go to fail safe position	Fail close position for the control valves: all feed valves are fail close, valves in cooling loops are open, 3 way valve fail safe in circulation position.				
-- Electricity	Power failure	Interrupts the whole process (monomer preparation)	UPS If UPS fails all instrumentation have to switch to it's safe position in case			Check how long UPS can supply	

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Safety Review - BASF-HAZOP		Primary Measures		Process Safety	
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Hypothetical Upset	Cause(s)	Effect(s)	Counter-measure(s)	RK	S	Open Point(s)	R
-- Total Utility Loss	Power failure No water supply	Interrupts the whole process (monomer preparation)	of power failure UPS for DCS If UPS fails all instrumentation have to switch to it's safe position in case of power failure In case of no water supply, major plant shutdown			electricity	

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Column 'S'-Abbreviations: Z = Class A Safety Installation; O = Organizational Measures; Y = Safety Valve/ Rupture Disc; E = Inherently Safe

ภาคผนวก ข.2

เอกสารทบทวนเหตุการณ์อุบัติภัย/อุบัติเหตุที่
เกิดขึ้นจากการประกอบกิจการอุตสาหกรรมที่มี
การผลิตลักษณะเดียวกันทั้งในประเทศและ
ต่างประเทศ

แก๊สพิษ

มีนาคม 2566



รูปที่ 1 คลอรีนรั่วไหลจากถัง (cylinder) ที่ร่วงหล่นลงมา

ที่มา : <https://www.voanews.com/a/jordan-negligence-responsible-for-aqaba-chlorine-tank-explosion-/6644453.html>

เกิดอะไรขึ้น?

เมื่อวันที่ 27 มิถุนายน 2565 ถังบรรจุแก๊สคลอรีนเหลว ขนาด 25 ตัน ร่วงลงมาจากเครนขณะกำลังยกขึ้นเร็ว ในเมืองอาคาบา ประเทศจอร์แดน สายเคเบิลที่ไต่ยก ขาดทำให้ถังหล่นลงมาชนกับดาดฟ้าเรือจนแตก แก๊ส คลอรีนสีเหลืองที่เป็นพิษฟุ้งกระจายออกมาจำนวนมาก คนงานต้องอพยพออกจากพื้นที่ มีผู้เสียชีวิต 13 ราย และอีกประมาณ 300 คนต้องเข้ารักษาตัวใน โรงพยาบาล

เจ้าหน้าที่ระบุว่าน้ำหนักของถัง "มากกว่าน้ำหนักที่สาย เคเบิลรับได้ 3 เท่า" และไม่ได้มีการจัดเตรียม มาตรการความปลอดภัยที่จำเป็นสำหรับการจัดการ สารเคมีอันตรายดังกล่าว ไม่มีผู้ควบคุมอยู่บนดาดฟ้า เรือในขณะนั้นที่สามารถทำการตรวจสอบอุปกรณ์ และขั้นตอนในการยก

ผู้เชี่ยวชาญกล่าวว่าเหตุการณ์นี้อาจรุนแรงกว่านี้ได้ ถ้าหากว่าคนงานจำนวนหลายสิบคนที่ออกจากกะยังไม่ได้กลับออกไปเพียงไม่นานก่อนที่จะเกิดการ รั่วไหลขึ้น โชคดีอีกอย่างคือทิศทางลมพัดแก๊สพิษ ออกจากพื้นที่ที่มีประชากรหนาแน่นในเมืองท่าไปยัง บริเวณที่เป็นทะเลทรายรอบนอก

ควรใช้ความระมัดระวังขณะทำการขนถ่ายสารเคมีหาก เกิดการรั่วไหล ไม่ว่าสารนั้นจะเป็นของแข็ง ของเหลว หรือ แก๊ส ในเหตุการณ์นี้ มีผู้คนจำนวนมากอยู่ใกล้ สถานที่ที่ทำการขนถ่ายสารเคมี ซึ่งคนเหล่านั้นไม่มีความจำเป็นที่จะต้องอยู่บริเวณนั้นในขณะที่เกิดเหตุ

คุณทราบหรือไม่?

- แก๊สพิษสามารถทำให้เกิดอาการเป็นพิษที่ความเข้มข้นค่อนข้างต่ำหาก สัมผัสกับร่างกายมนุษย์
- แก๊สพิษมักถูกจัดกลุ่มเป็น สารที่ทำให้เกิดระคายเคือง เช่น คลอรีน และ แอมโมเนีย สารที่ทำให้ขาดอากาศหายใจ เช่น ไนโตรเจน และ คาร์บอนมอนอกไซด์ สารที่ทำให้มีอาการชา เช่น ไนโตรสออกไซด์ และ สารพิษเป็นพิษ เช่น ไฮโดรเจนซัลไฟด์ และ ไฮโดรเจนไซยาไนด์
- การสูดดมสารพิษอาจทำให้เสียชีวิตได้อย่างรวดเร็ว เนื่องจากปอดเป็น เส้นทางตรงไปยังกระแสเลือด สารบางตัวสามารถซึมผ่านผิวหนังและ ดวงตาได้เช่นเดียวกัน
- แก๊สพิษเป็นอันตรายอย่างยิ่งเพราะมักถูกจัดเก็บและขนส่งภายใต้ความดัน หากเกิดการรั่วไหลจะสามารถขยายตัวและเคลื่อนที่ไปในอากาศอย่าง รวดเร็ว แก๊สหลายตัว เช่น ไฮโดรเจนซัลไฟด์ และ คาร์บอนมอนอกไซด์ ไม่มีสีและไม่มีกลิ่นไว้วางใจ หรือ ไม่มีกลิ่นเตือนให้รู้เลย
- งานยกเคลื่อนย้ายเป็นงานที่อันตราย ในบางบริษัทและบางประเทศ จำเป็นต้องมีแผนการยกเคลื่อนย้ายแบบเป็นทางการ องค์ประกอบสำคัญ สำหรับแผนดังกล่าวและมาตรการความปลอดภัยสำหรับงานยกของหนัก ในพื้นที่ที่มีสารอันตรายร้ายแรงอยู่จะกล่าวถึงใน Beacon ฉบับถัดไป

คุณสามารถช่วยอะไรได้บ้าง?

- การเตรียมการสำหรับการดำเนินการที่เกี่ยวข้องกับการจัดเก็บ ขนถ่าย ใช้ งาน สารเคมีที่เป็นแก๊สพิษควรต้องครอบคลุมสิ่งที่ต้องปฏิบัติหากเกิดการ รั่วไหลด้วยเสมอ :
 - ✓ **ต้องตระหนักถึง** สารเคมี และ อุปกรณ์ที่ใช้ งาน ผู้คนและ สภาพแวดล้อมในบริเวณที่คุณปฏิบัติงานอยู่เสมอ
 - ✓ **อ่านและปฏิบัติตาม** คำเตือนบนฉลาก ป้ายประกาศ และ เครื่องหมาย ต่าง ๆ ในบริเวณที่มีการจัดเก็บและใช้งานแก๊สพิษ
 - ✓ **อยู่ห่างจากบริเวณที่มีการยกเพื่อเคลื่อนย้าย และ** เตือนบุคคลอื่นที่อยู่ ใกล้จนเกินไปให้ย้ายออกมา
 - ✓ **รู้ว่าจะต้องไปที่ไหน และ** ต้องปฏิบัติตามขั้นตอนใดหากมีการรั่วไหล เกิดขึ้น
 - ✓ **อย่าเข้าไปเกี่ยวข้องกับ** แก๊สพิษรั่วไหล เว้นแต่คุณเคยได้รับการ อบรมและมีอุปกรณ์พร้อมสำหรับการโต้ตอบเหตุการณ์ฉุกเฉิน อพยพ ไปด้านเหนือลมและห่างจากเส้นทางที่แก๊สรั่วไหลออกมาเพื่อไปยัง สถานที่หลบภัยที่ได้รับอนุมัติว่าปลอดภัย
 - ✓ **ใส่ ทดสอบให้พอดี และ ใช้** เครื่องช่วยหายใจ (respirators) อุปกรณ์ ป้องกันส่วนบุคคลอื่น ๆ และเครื่องวัดแก๊สแบบเคลื่อนที่ ที่ได้รับ อนุญาต พร้อมใช้งาน และ เหมาะสมกับการรั่วไหลที่เกิดขึ้น

การสูดดมแก๊สพิษอาจทำให้เสียชีวิตได้ ปฏิบัติอย่างถูกต้องเพื่อป้องกันตนเองและผู้อื่น

อันตรายจากงานยก (Lifting hazards)

เมษายน 2566



รูปที่ 1. สายเคเบิลขาดขณะทำการยกถังบรรจุคลอรีน

Beacon ฉบับเดือนมีนาคมได้กล่าวถึงอุบัติเหตุที่เกิดขึ้นที่ท่าเรืออะคาบา ประเทศจอร์แดนที่มีถังบรรจุแก๊สคลอรีนเหลวร่วงลงมาจากเครนกระแทกดาตฟ้าเรือขณะกำลังยกขึ้นเรือทำให้มีแก๊สคลอรีนรั่วไหลจำนวน 25 ตัน มีผู้เสียชีวิต 25 คนและอีกมากกว่า 300 คนต้องเข้ารักษาตัวในโรงพยาบาล Beacon ฉบับนั้นโฟกัสไปที่อันตรายของแก๊สพิษ ส่วน Beacon ฉบับนี้จะโฟกัสไปที่สาเหตุทางกายภาพที่ทำให้เกิดอุบัติเหตุขึ้น: ระบบการจัดการที่ไม่ดีพอในการยกสารเคมีอันตรายขึ้นหรือลง เจ้าหน้าที่ระบุว่าน้ำหนักของถังที่ยก "มากกว่าความสามารถในการรับน้ำหนักของสายเคเบิลถึง 3 เท่า"

วิดีโอแสดงให้เห็นว่าสายเคเบิลขาดและถัง (isotainer) ตกออก รูปที่ 1 มี 2 ภาพนิ่งจากวิดีโอ [ดูวิดีโอได้จาก : <https://youtu.be/OXYKMS6IMUs>]

เจ้าหน้าที่ระบุเพิ่มเติมว่าไม่มีมาตรการความปลอดภัยที่จำเป็นสำหรับการจัดการสารเคมีที่มีอันตรายแบบนี้จัดเตรียมไว้และไม่มีผู้ทรงคุณวุฒิอยู่บนดาตฟ้าเรือ ณ ขณะนั้นที่จะทำการตรวจสอบขั้นตอนการยกขึ้นและยกลง

คุณทราบหรือไม่?

- การยก ไม่ว่าจะเป็นการเคลื่อนย้ายอุปกรณ์ในกระบวนการผลิต หรือ สารเคมี เป็นกิจกรรมที่อันตราย ในบางบริษัทหรือบางประเทศ จำเป็นต้องมีการจัดทำแผนการยกแบบเป็นทางการและต้องได้รับการอนุมัติก่อนที่จะเริ่มทำการยก สำหรับประเด็นที่ต้องมีการพิจารณาในแผนการยก หรือ ใบอนุญาต เช่น :
 - อุปกรณ์ที่ใช้ในการยกต้องรองรับน้ำหนักของวัตถุที่ถูกยกได้ ควรมีระบุไว้ว่าอุปกรณ์นั้นรับน้ำหนักได้เท่าไร (rated capacity)
 - สายเคเบิลที่ใช้ยกมีช่วงอุณหภูมิที่กำหนดไว้เพื่อการใช้งานอย่างปลอดภัย
 - อุปกรณ์ที่ใช้ในการยกต้องได้รับการตรวจสอบก่อนใช้งาน
 - คนควบคุมเครนและริกเกอร์ต้องได้รับการรับรอง (certified) สำหรับการใช้งานอุปกรณ์ที่ใช้ในการยก
- คนควบคุมเครนควบคุมการเคลื่อนไหวของเครน ริกเกอร์ทำการต่ออุปกรณ์ที่ใช้ยกเข้ากับวัตถุที่ต้องการยก ให้สัญญาณคนควบคุมคนเครนระหว่างทำการเคลื่อนย้ายและปลดวัตถุที่ถูกยกออกจากอุปกรณ์ที่ใช้ยก
- ในการจัดทำแผนการยก ต้องพิจารณาสภาพอากาศด้วย
- หากมีการยกสารเคมีอันตราย หรือ วัตถุใด ๆ ข้ามอุปกรณ์ที่ใช้งานกับสารเคมี ควรพิจารณาจัดเตรียมแผนการโต้ตอบเหตุฉุกเฉินที่อาจจำเป็นในส่วนหนึ่งของการจัดทำแผนการยกด้วย

คุณสามารถช่วยอะไรได้ ?

- ตรวจสอบว่าผู้ที่เกี่ยวข้องทุกคนรับทราบแผนการยกและทราบบทบาทของพวกเขาที่เกี่ยวข้องกับแผนการยกนั้น
- ตรวจสอบว่าคนควบคุมเครนและริกเกอร์ใช้สัญญาณมือเดียวกัน แม้ว่าจะมีการสื่อสารทางวิทยุด้วยก็ตาม
- ตรวจสอบตำแหน่งสุดท้ายของสิ่งที่กำลังยกเพื่อให้มั่นใจว่ามีพื้นที่เพียงพอสำหรับวางและทุกอย่างได้ถูกเคลื่อนย้ายออกจากพื้นที่แล้ว
- ห้ามดันสัด** หากไม่สามารถทำตามแผนการยกที่เขียนไว้ได้ ให้หยุด! ทบทวนสถานการณ์และให้คนที่เหมาะสมเข้ามามีส่วนร่วมในการแก้ไขแผนการยกนั้น ซึ่งรวมถึงผู้ที่เป็นคนอนุมัติแผนการยกเดิมและบุคคลอื่น ๆ ที่เกี่ยวข้อง
- กันผู้คนออกจากพื้นที่ อย่ายอมให้ใครเดินผ่านใต้สิ่งของที่กำลังยกโดยเด็ดขาด
- ตรวจสอบสภาพอากาศ ลมและฝนสามารถทำให้กิจกรรมการยกอันตรายมากขึ้น ต้องรู้ว่าเมื่อไรควรหยุดการยก

ในขั้นตอนการยกต้องมั่นใจว่ามีการปฏิบัติตามข้อควรระวังด้านความปลอดภัยทั้งหมดก่อนเริ่มงาน!

Sense of vulnerability – a very important safety component

June 2023



A person walking through a process area that handled sulfuric acid noticed an operator preparing to disconnect a nitrogen hose. The operator was not wearing the complete Personal Protective Equipment (PPE) required for the area, which included a face shield. The person stopped, pointed out the situation, and the operator willingly complied. The first person had only gone a few more steps when he heard a 'pop' and 'hissing' from the sulfuric area. The operator was drenched in acid and was helped to the nearest safety shower.

Unknown to the operator, sulfuric acid had backed up into the nitrogen hose. When it was disconnected, pressure sprayed the acid toward the operator's face and body. The operator received only a few minor chemical burns on his neck because the required PPE had been worn.

During the investigation, the operator's face shield was found to be severely corroded and had a stain in the center where the acid had sprayed it. Without the face shield in place, the operator would have been seriously burned and could have permanently lost his vision.

Why did the first person stop and remind the operator of the complete PPE? A sense of vulnerability. The observer saw the potential for the hose to have acid in it, even though it SHOULD only contain nitrogen.

Did You Know?

- What does a "sense of vulnerability" mean? It means that everyone in your plant:
 - Understands the hazards associated with the materials and process conditions (pressure, temperature, etc.) in the area.
 - Is constantly vigilant for symptoms of weaknesses that might indicate more serious events ahead, such as a small leak that could become a major line failure.
 - Stays vigilant even if the plant has good safety performance.
- In our personal life, a sense of vulnerability is what causes us to slow our driving speed in bad weather or to be more cautious when working on a ladder.
- We can lose our sense of vulnerability when we are in a hurry. That can cause us to skip steps or forget to wear the correct PPE.
- New employees may bring their sense of vulnerability from an earlier job or company. That means we may need to help them understand the hazards in their new job.
- Maintaining a sense of vulnerability is an essential characteristic of a good process safety culture.

What Can You Do?

- If you see an at-risk behavior, stop, and ask the person if they are following the correct procedure. You could keep someone from being seriously hurt – or worse.
- If someone stops you to ask about how you are performing a task, do not be defensive. They are trying to keep you safe. Answer their questions calmly, be open to their suggestions on how to perform the task and thank them for their concern about your safety.
- If your area has newer employees, coach them on the unit hazards and procedures. Help keep them safe!
- Never think, "It can't happen here." It can!

Sense of vulnerability – your process safety "spider sense"

ภาคผนวก ข.3

ฐานข้อมูลสุขภาพของพนักงาน

BASF Group in Thailand

Standard Operating Procedure		Title: Occupational Health Management	
Issued by: RC steering Committee		Effective as from: 17 October 2022	Document No.: SOP-RC 4-1
First Issue dated: 25-Mar-05			Page: 1 of 27
Approved by: RCMR		Superseded Previous Issue	New Revision No.: 11
Latest Approved date: 17 October 2022		Revision No.: 10 Dated: 16 Aug 17	Revision date: 17 October 2022

Purpose

The overall goal of the BASF Corporate Health Management Requirement is to protect each employee's life and health at the workplace and to assist in assuring that BASF products do not pose health risks to employees, customers, and the general population when handled properly.

Scope

This procedure defines the BASF minimum standards in Occupational Health (OH). All BASF Group companies must implement these standards as far as possible. If there are any legal obligations which collide with these standards or if national standards are more stringent, than those have to be followed.

References

- G-R-OCH 001 Corporate Health Management; Revision 1, April 2017
- Ministerial Regulation on Prescribing of Criteria and Method of Conducting Health Check Up of Employees and Forwarding the results of Health Check Up to Labor Inspector B.E. 2547 (A.D. 2004).
- Defining chemicals list that owner must provide medical examination for employee who expose with B.E. 2552

Definition

Site is a term in this requirement that refers to all types of sites operated by the BASF Group (production, research, sales, administration, etc.) Occupational Health performance standards apply to all types of business operations.

Regional Coordinating Occupational Health Physician (RCOHP) is a medical doctor who is a specialist in occupational health and coordinates all OH activities in a region. He/she advises the regional management and maintains contact with all CCOHPs in the region, as well as with the Corporate Health Management Department in Ludwigshafen.

Country Coordinating Occupational Health Physician (CCOHP) is a medical doctor who is a specialist in occupational health and coordinates all OH activities in a country. He/she advises the country management and maintains contact with the RCOHP and the SOHPs in the country. Furthermore, the CCOHP supports the sites to implement and maintain high standards in OH according to this requirement. He/she ensures professional qualification and checks performance of external medical service providers. Depending on the organizational structure in a region, it is possible that the CCOHP is responsible for several countries. In addition, the task of the CCOHP can either be assigned to a SOHP or the RCOHP coordinates all activities of the SOHPs, depending on the number of sites and employees in a country.

Site Occupational Health Physician (SOHP) is a medical doctor trained in occupational health who is responsible for the medical services at a BASF location. Depending on local conditions as well as size and type of operations, different models of occupational health services are possible e.g., on-site medical services (with permanent or part-time presence), medical services from an external provider, etc.

Industrial Hygienist is a person with adequate qualification and experience in the practice of Industrial Hygiene according to recognized national standards.

Occupational Health includes all aspects of Occupational Medicine, Medical Emergency Preparedness and Response, Health Promotion, Health Prevention and Rehabilitation, Health Risk Assessment, Industrial Hygiene, Human Toxicology, Human Biomonitoring, etc.

BASF Group in Thailand

Standard Operating Procedure		Title: Occupational Health Management	
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Occupational Health Staff includes RCOHP, CCOHP, site occupational health physician, responsible for IH and Human Biomonitoring, occupational health adviser, lead nurse and occupational health nurse, lead paramedic and paramedic.

RC OH Audit (see G-R-AUD 001) is the corporate health performance revision tool conducted by approved medical auditors.

Health Management System represent all relevant OH services. Tasks and responsibilities are described in procedures, communicated to all BASF employees and executed in a responsible way. Effectiveness and quality are regularly evaluated in terms of a quality management and a continuous improvement process is implemented.

Health Contact Person is a BASF employee in charge of managing OH topics at a site in absence of internal medical staff, i.e.:

- Ensure each employee at the site has his/her exposures and medical surveillance requirements defined
- Establish and maintain a contract for service with a local provider/clinic/hospital that will perform various medical functions including periodic medical exams, pre-placements exams, drug and alcohol testing, occupational injury evaluations and treatment, plant tours and hazard assessments
- Monitor and ensure compliance for all site employees with periodic examinations
- Be aware of medical program updates and changes that apply to the site

Exposure Assessment is the process of estimating, calculating or measuring the magnitude, frequency and duration of exposure to a hazardous substance. It takes into account the sources, pathways, routes, and the uncertainties in the assessment.

Hazardous Substance means any chemical with the intrinsic property, which has the potential to cause harm to the health of a person.

Occupational Exposure Limit (OEL) is a term used to express the exposure level of an agent assigned by regulatory body or occupational health groups. It is regarded as the concentration to which workers can be exposed without adverse health effects.

Target Group Responsibilities

Target Groups are globally defined under G-GD-EHS 002. Following target groups are not defined therein:

HR Organization includes employees fulfilling HR duties for the BASF Group Companies and sites.

Worker Representatives are worker councils or unions representing the interest of BASF employee.

Group Company: As legal entities, BASF Group companies develop internal procedures that define the implementation of legal standards in occupational health as well as the BASF standards defined in this requirement.

This is particularly efficient for all sites of that Group Company for which those procedures are applicable. BASF employees who are not part of a site organization, i.e., marketing and sales people or other remote workers should be covered also and shall have the same access to OH services.

Site Managers assume the responsibilities for OH topics at a site and to implement the performance standards defined in this requirement. If there is no internal medical staff on site, the site management shall nominate a health contact person to be the permanent contact for the CCOHP.

Plant Managers are responsible and accountable for the health protection topics at the workplaces, for health education, first aid and periodic examinations.

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Procedure

1. Principle

1.1 Policy

It is the responsibility of management and OH staff to be informed about all national and company-specific regulations concerning OH and IH, and to comply them with the daily business operations. The OH staff is expected to apply his/her expertise in interpreting and implementing legal regulations.

Occupational health is an integral part of business management. Therefore, there should be a policy-based health management system in each BASF Group company or on site level that takes into account the local situation, legal requirements, corporate guidelines and standards.

The responsibilities and services for contracted workers and leased personnel on-site have to be clearly defined in the site-specific management system.

1.2 Organization

The responsibilities of the occupational health personnel and a description of important interfaces with other departments or working groups should be defined. The SOHP should be member of RC committee and should participate in meetings any time OH relevant topics are discussed.

The SOHP should have the opportunity to directly report OH issues to the site management.

Management and the occupational health physician should meet on a regular basis to discuss issues regarding occupational medicine. The management should be aware of the scope of OH services. All employees should have access to the available medical services.

1.3 Cooperation

The OH services of a site should work closely together with safety, human resources and worker representatives.

The SOHP should also have a close link to the responsible RCOHP in order to support adherence to BASF standards.

The SOHP should have access to FEH professional information and the FEH Centers of Expertise at BASF headquarters in Ludwigshafen.

1.4 Quality Management

The performance and quality of the occupational health services should be assessed on a regular basis. For these purposes, performance indicators should be determined. Implementation of the BASF HPI (Health Performance Index) is a minimum requirement. If there are specific local needs that require other KPIs, those should be implemented additionally.

Goals with regard to Occupational Health should be defined at least annually– either derived from regulations and legislation or self-imposed. If leasing employees or contracted workers are not under the scope of the site's medical department, it should be part of the site's contractor management that

- (1) the workers and their employer are sufficiently informed about the health hazards and
- (2) fitness-to-work is documented.

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2. Occupational Health Staff

2.1 Qualification

The occupational health physician and the medical staff should be qualified specialists and should have the necessary experience in the practice of occupational health, according to national standards. The occupational health physician should be an active member in medical and occupational medical working groups and professional associations. Participation in these associations should be supported by management.

OH staff responsible for Industrial Hygiene should have adequate qualification and experience in the practice of Industrial Hygiene according to recognized national standards.

OH staff should be encouraged to attend continuing education programs and training seminars to keep up to date on professional issues, broaden the knowledge base and improve technical skills.

During the annual employee's performance review of the BASF OH staff, individual and task specific training needs should be cleared and specified. Each OH staff should be sufficiently trained for their responsibilities. This includes training in advanced cardiac life support and trauma life support on a regular basis.

For external OH staff these continuing and annual training needs should be defined in the contract.

2.2 Working Time

The working hours of the OH staff should correspond to national legal requirements and the needs of the company.

The services provided by the occupational health physician and other OH staff (e.g., nurses, paramedics, technical assistants) should cover the needs of each site. Thai Regulatory shall be fulfilled including;

- The site contains employees more than 200 persons which should be provided
 - At least one Nurse in all working time
 - At least one Medical doctor work on site at least 2 times per week and total 6 hrs. per week

2.3 Responsibilities

The primary responsibility of the occupational health staff is the protection of each BASF employee's life and health at the workplace. The main tasks are:

- Medical examinations
- Health risk assessment and plant visits
- Prevention of adverse health effects and disease prevention
- Early diagnosis of work-related diseases
- Health education
- Health promotion
- Rehabilitation
- Medical consultations
- Medical emergency response planning

For on-site occupational health physician, an additional task is to provide acute medical care.

The tasks and responsibilities of the OH staff should be defined in the job description. In case of contracted OH staff, the service contract should define these responsibilities.

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2.4 Plant Inspections

The OH staff should be familiar with the workplaces, the various work environments, the hazardous substances handled and the products manufactured at the site. Each production facility and laboratory with specific health hazards should be visited on a regular basis, at least annually. During the plant inspections, special attention should be paid to ergonomics and the handling of hazardous substances. The work environment of contract workers should also be evaluated. The plant inspections performed by the SOHP can also be delegated to other medical staff qualified in conducting plant visits, e.g., occupational health advisors. Plant inspections from a medical perspective contributes to the health risk assessment. OH staff responsible for industrial hygiene should regularly visit the plants and work places and support health risk assessment.

Following a plant visit, recommendations for improvements should be made for workplaces where there may be a potential hazard to employee's health. Plant inspections, as well as the recommendations given, should be documented in writing in a standardized form. For more information on conducting plant inspections refer G-P-OCH 040 Occupational Medicine & Health Protection Plant Inspection Guideline

3. Medical Facilities

3.1 Site Medical Clinic

The medical facility (e.g., first aid room, medical consultation and examination room, on-site medical clinic) on site has to correspond to the local setting. Factors which influence the type of facility are the medical services provided on-site and the existing infrastructure and public health services in the vicinity of the site.

The minimum requirement should be a sufficiently equipped first aid room. For non-production environment (e.g., offices, laboratories) also a first-aid-corner or multipurpose room is acceptable, as long as privacy and medical confidentiality are ensured during use.

An on-site medical clinic should have separate rooms designated for consultation, physical examinations, emergency treatment and the safe storage of medical records. If medical examinations are performed on-site without the existence of a designated examination room, a temporary room with sufficient furniture, examination equipment and privacy must be available.

The medical facility – ideally located on the ground floor – should be easily accessible with a stretcher and clearly signed.

The hygienic conditions of the medical facilities should have a high standard.

3.2 First Aid Equipment

First aid kits should be only used for the initial treatment of work-related injuries. There should be a sufficient number of first aid kits throughout the site, to guarantee, in case of need, the immediate access to first aid material. The kits should be standardized according to legal regulations.

An example of the recommended first aid material can be found in the SOP-RC 4-2 Medical Emergency Preparedness and First Aid. It has to be ensured that they are always well maintained and filled up. Every usage of the first aid kit has to be documented.

First aid equipment (such as first aid kits, immobilization material, stretchers, emergency showers, eye washes, decontamination products) must be available according to the health risk assessment.

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3.3 Technical Equipment

Technical equipment has to be calibrated and maintained according to international standards and instruction manuals.

Technical equipment must be available according to the health risk assessment.

3.4 Information on Toxicology of Substances

Relevant toxicological information should be available, in local language or at least in English, in the medical facility for all hazardous substances handled on site, i.e., MSDS, BASF Chemical Emergency Medical Guidelines (CEMGs), other information on human toxicology and treatment of contaminations and intoxications.

Information on Toxicology of Substances shall be available in;

- First Aid room
- Emergency Command Center room
- The nearest hospital or contracted hospital

BASF Chemical Emergency Medical Guidelines

https://www.basf.com/en/company/sustainability/employees-and-society/employees/occupational-medicineand-health-protection/Medical_Guidelines.html

Poison center which can be contacted hotline 1367 telephone on a 24-hour basis.

4. Medical Examinations

4.1 Pre-placement Examinations

Before working at a workplace with specific occupational exposures or which require certain medical fitness, a pre-placement examination must be conducted.

The content of this pre-placement examination should cover the same content as the periodic health examinations for this workplace. The examining physician has to be familiar with the workplace and its exposures.

For workplaces without a specific occupational health risk or requirements for a certain fitness, pre-employment examinations should only be performed if there is a legal regulation in country.

4.2 Periodic Examinations

In general, periodic examinations are either medical surveillance examinations or fitness-to-work examinations. As long as there is no conflict with national regulations the following standards should be implemented:

- Medical examinations for all workers with specific workplace exposures, hazards or requirements identified in the workplace health risk assessment
- Examination to be conducted in every year.
- Examining physician has to be familiar with the workplaces and exposures
- Medical examination and diagnostic testing should be designed according to particular hazards or requirements (examination protocol)
- For each of these protocols trigger criteria, contents of examination, assessment criteria and intervals should be clearly defined
- Different protocols can be combined in one periodic examination (e.g., medical surveillance, fitness-to-work) or even with a general medical examination. In such cases the different purposes of the examination

must be transparent

Internal

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- Medical and occupational history and physical examination should be included in all protocols
- The selection of technical medical examinations i.e., audiometry, vision test, lung function test, ECG, X-ray and laboratory tests i.e., blood count, liver enzymes, renal function, strongly depends on the specific exposure or duty
- Participation is either mandatory or voluntary, depending on the nature and purpose of the examination in accordance with the legal context. In case of a voluntary examination, management is only informed about the participation of the worker, not about the outcome. After a mandatory examination, the SOHP provides a fitness-to-work certificate that states fit-to-work, temporary or permanent restrictions or unfit-to-work without disclosing other medical information
- The fitness-to-work assessment should be provided separately for each examination purpose and an individual certificate should be issues for each assessment

Medical surveillance examinations

Medical surveillance is the systematic monitoring of employees for early identification of health effects that may be related to workplace exposures i.e., occupational diseases. Medical surveillance programs also serve to evaluate the effectiveness of existing workplace preventive strategies. If workers leave the workplace and therefore the specific exposures ceases (change of workplace, retirement), an exit examination should be considered especially when the previous surveillance examination was more than 12 months ago.

Medical surveillance examinations should be offered according to the evaluated exposures. Specific medical surveillance examinations should be established for the following exposures:

- **Chemical hazards:** The examination protocol should focus on target organs and typical health effects of the particular hazardous substance. Examples: Benzene and Benzene homologues, Chromium, Ethylene oxide/ Propylene oxide, Lead, Mercury, Nickel, Aromatic nitro and Amino compounds, Butadiene, Solvents, Carbon monoxide, Methanol, Hydrogen sulfide, Chlorinated hydrocarbons, Arsenic, Isocyanates, Cadmium, Styrene, Vinyl chloride, Crystalline silica, CMR-substances, sensitizing substances, etc.
- **Biological hazards:** In case of exposure to human-pathogenic germs, the periodic examination should include a lab test for antibodies in the blood to detect infection and to check vaccination status.
Vaccination should be offered if applicable. Depending on the germ relevant target organs should be examined accordingly e.g., liver enzyme if there is a risk for hepatitis.
In case of exposure to foreign sensitizing proteins the examination should focus on skin symptoms and lung function.
- **Noise:** A hearing conservation program including audiometric testing is mandatory if the noise exposure equals or exceeds an 8-hour time weighted average of 85 dB(A) and should be offered if TWA equals or exceeds 80dB(A). Relevant elements are:
 - Baseline audiogram prior to first noise exposure
 - Quiet examination room or booth and absence of noise exposure 14 hours prior to the test
 - Systematic pure tone testing procedure and detailed instructions
 - Evaluation of temporary and permanent STS
 - Consideration of age adaptation
 - Preventive measures and revision of the baseline in case of confirmed STS
 - Criteria to determine work-relatedness of STS
- **Dust:** Especially if air concentration for respirable dust is >10mg/m³
- **Dermal irritants or wet work:** workplaces that pose a specific risk for the skin i.e., exposure to abrasive particles, dermal irritants or wet work over 4 hours. Continuous wearing of water proof gloves over 4 hours is also considered wet work
- **Ionizing radiation**
- **Ergonomic exposures (repetitive movements, manual handling or heavy loads, office ergonomics) and**

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vibration (hand-arm and whole body vertical)

Fitness-to-work examinations

Fitness-to-work examinations are necessary if workplaces require a certain physical or mental fitness. Usually these are mandatory examinations and management is informed about the outcome via a fitness-to-work certificate.

If national legal framework requires additional agreements with the workers or their representatives, all reasonable efforts should be taken to implement the listed fitness-to-work examinations:

- Respirator clearance: A medical fitness-to-work assessment is indicated when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar. Assessment criteria should include the result of pulmonary function testing. If respirators with compressed air are used, cardiovascular fitness should also be assessed.
- Rescue team: Assessment criteria should include stress-ECG to determine cardiovascular fitness or acknowledged alternative examinations
- Mobile equipment operations and professional driving: Assessment criteria should include result of vision test (for specific tasks tests on binocular vision, visual field, color vision, etc. may be required)
- Business travel: A medical examination should be offered to transferees and dependents, frequent business travelers and travelers with an elevated travel health risk.

For many other kinds of workplaces there is also a need to certify a certain physical or mental fitness. The examination protocols have to be designed in order to verify the required fitness. Frequent examples are:

- Lone work or remote location (e.g., off-shore)
- Confined space
- Working at night or in rotating shifts
- Food handling / Good manufacturing practice
- Heat work
- Work at heights
- Work in oxygen reduced atmosphere

General Medical Examinations

These examinations can also be offered as a part of the corporate health promotion program (BASF Health Check) and therefore should be aligned with the SOHP. They serve to identify health conditions and risk factors at an early stage in order to advise and treat employees, if necessary (or to refer them to a specialist for further investigation). The results of each medical examination should be discussed with the employee.

General medical examinations should include:

- Medical history
- Physical examination
- Laboratory tests (e.g., blood count, blood sedimentation rate, liver enzymes, blood sugar, cholesterol, urinalysis, stool test for occult blood)
- Pulmonary function test, ECG, chest X-ray, if clinically indicated

The medical examination is presented in Annex 3.

Post-injured medical examination

- Post injured medical examination assess the health performance of the employee after sick leave from

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injury more than 3 days. Or injuries that do not work in the same function (Restrict Duty Injury) regarding to Ministerial Regulation on Prescribing of Criteria and Method of Conducting Health Check Up of Employees and Forwarding the results of Health Check Up to Labor Inspector B.E. 2547 (A.D. 2004).

4.4 Human Biological Monitoring

Human Biomonitoring is an established tool for the determination and assessment of individual exposure and can also serve for consolidated group-based analyses. It also provides feedback on the efficiency of safety and health protection measures under routine operations and on the intensity of an accidental or single peak exposure.

Therefore, chemical health risk assessment should always consider the applicability and feasibility of HBM. Recognized assessment values and validated procedures to measure these chemicals in biological specimens are prerequisites.

A specific focus should be on CMR-substances, substances with a skin notation, substances which accumulate in the body and if PPE is an essential element of health protection and if the significance and validity of personal air monitoring is limited.

Written protocols for HBM should be developed and reviewed, taking into account the pharmacokinetics of the chemical substance, workplace organization and specimen handling. Collaborating HBM laboratories should substantiate their ability to deliver reliable results.

5 Health Promotion, Prevention and Rehabilitation

5.1 Health Promotion

Health promotion should support the well-being of employees and can help to reduce loss of productivity through absenteeism and presenteeism. All health promotion programs should strive to close relevant gaps in already existing offers by insurances or public health care systems. Health promotion services should be designed according to sites' needs. A sustainable health promotion program on site level should cover the following elements:

- BASF general Health Check, to be offered to each employee, independent of his workplace, at least once in every three years. For workers, older than 50 an annual check-up is recommended
- Participation in the global BASF Health Promotion Campaign and/or a site-specific topic for a Health Promotion Campaign to raise awareness among the workers
- Depending on the local setting, a continuous offer of targeted health promotion activities and services
- according to the most relevant health conditions and risks among the group of employees
 - Health promotion concepts to increase awareness for a healthy lifestyle, healthy nutrition and cardiovascular fitness and to increase resilience against back pain and psychomental disorders.
 - Programs that detect risk factors early i.e., cardiovascular risks and chronic diseases i.e., hypertension and diabetes have been proven a good return on investment.
 - Cancer screening programs are only recommended for a selection of cancers i.e., colon cancer, skin cancer and leukemia). There must be strong medical evidence that screening tests conducted are sensitive, specific and that early detection of condition will increase survival rate and quality of life.
 - Smoking cessation programs are among the most important health promotion offers. Therefore they should be available to all smokers on a regular basis.

The SOHP should be involved in the planning of all health promotion activities in order to ensure medical value.

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5.2 Health Prevention

Every employee has to be informed periodically about the specific health risks at the workplace and how to cope with these risks. In addition, general information, i.e., instructions, brochures, presentations, e-learning, or other information via media should be offered. In particular, clear instructions have to be provided on correct use and storage of PPE. For planning and, where applicable, conducting trainings a qualified medical professional should be involved:

- Skin protection refer to SOP-RC 4-8 Occupational Skin Diseases - Recognition and Prevention: An elevated risk for skin disorders has to be considered at workplaces with inevitable direct skin contact to sensitizing substances or substances that can damage the skin by defatting, mechanically irritating particles and wet work (hands in wet environment or wear liquid-proof occlusive gloves > 4 hours/day). Also frequent hand-washing (> 20 times a day) or extensive exposure to UV radiation has to be considered in the health risk assessment. At all washing facilities within a working area where there is a risk for occupational skin diseases, skin care products should be selected according to the needs of the workplace. A complete skin protection program consists of: skin protection agents (e.g., barrier cream), cleansing agents, skin care products, paper towels and information about correct use of products (e.g., posters or pictures). Note: Barrier creams cannot be used as a substitute for PPE such as gloves or protective clothing.
- Hearing protection refer to SOP-RC 4-9 Hearing Conservation All workers included in a hearing conservation program should receive initial and annual training and information on the following topics: Location of high noise, hearing protectors, effects of noise on hearing and health, also considering non-work related noise exposure.
- Hazardous substances: Health hazards and correct use of PPE
- Musculoskeletal disorders (e.g., proper ergonomics: lifting and carrying)
- Pregnant women at the workplace refer to SOP-RC 4-3 Reproductive Health: There should be a process that supports women to inform their supervisor about a pregnancy in an early stage. Following a workplace assessment on reproductive hazards it has to be decided if the woman can continue to work or if she has to change the workplace. SOHP should be involved in the analysis and offer consultation.
- Protection of non-smokers: Non-smokers have to be effectively protected from smoke-exposure at all times.
- Health management of BASF transferees and business travelers refer to SOP-RC 4-7 Health Management for BASF Business Travelers and Transferees should be available especially when traveling to destinations with an elevated health risk (e.g., tropical countries, regions with poor medical infrastructure, etc.) and for frequent travelers (more than 12 weeks or more than 10 multiday travels per year). In the event of an emergency, medical attention and a medical emergency treatment should be guaranteed.
- Coping with rotating shifts and night work

5.3 Infectious Disease Prevention

- Vaccination programs should be designed to suite local risks. Typical examples are: Seasonal Influenza, Tetanus, Diphtheria, and Hepatitis. In addition there should be information and training about personal hygiene and prevention from severe local infectious diseases i.e., STD, tuberculosis and mosquito bites.
- Food hygiene and hygiene conditions in canteens and kitchens should be monitored on a regular basis and kitchen staff should follow a food hygiene management system i.e., HACCP. The SOHP should be involved in this hygiene program.
- Pandemic preparedness planning refers to SOP-RC 4-6 Pandemic Preparedness Planning Manual also depends greatly on the local setting. Therefore, each site should have an individual pandemic preparedness plan based on the organizational structure, the management of hygiene and infection prevention, medical emergency management and communication with internal and external stakeholders. All pandemic preparedness plans should be agreed upon by the regional management and integrated in the business continuity plan to ensure optimal internal communication and coordination in the event of a

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pandemic.

- All employees should have access to suitable drinking water.

5.4 Rehabilitation

After **more than 3 weeks** there should be a structured return-to-work process. Management, HR Manager and/or EHS manager are responsible for assuring the provision of assistance to employees returning to work and provide a fitness-to-work certification for the management. The return-to-work process should also be started if the employee or supervisor are suspicious about fitness-to-work even if the absence time is lower than the standard.

A fitness-to-work assessment should be always initiated if there are concerns about the ability of a worker to safely and reliably perform his/her duties. Medical assistance and rehabilitation programs should also be available to employees with mental disorders, alcohol addiction or drug addiction.

6 Medical Emergency and Emergency Response

6.1 Emergency Preparedness

For every BASF site, an emergency response plan (ERP) defines the relevant resources, procedures, tasks and responsibilities required to manage medical emergencies, including mass casualty incidents (MCI). It should include detailed procedures for the emergency call, first aid, medical emergency treatment and transportation to a suitable clinic or hospital. The ERP structure should consistently aim for an immediate emergency response and avoidance of any unnecessary delay.

BASF sites are classified in three risk categories in terms of medical emergency preparedness. The risk category is calculated as the product of the total number of people on site (BASF employees + permanent contractors + leasing personnel) and the health hazard, as determined in the RC OH Audit, according to the following table:

Table 2.6.1-1 Risk Category

Site Risk	Category
> 3000	A (high)
1000 - 3000	B (medium)
< 1000	C (low)

A site can be classified in a higher risk category if the site management deems it appropriate. Sites without any production activities are automatically classified as risk category C.

Unannounced simulations of medical emergencies (medical drill) should be conducted at least once a year to verify the functionality and effectiveness of the site's medical emergency response. Medical drills with multiple casualties and the resulting need of applying a triage system should be performed at least biannually at risk category B sites and annually at risk category A sites.

Detail information can be found in SOP 4-2 Medical Emergency Preparedness and First Aid

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6.2 Organization of First Aid

At all BASF sites, a minimum of 5% of the workforce in each area must be certified first aiders. For production areas the minimum percentage of certified first aiders is 10%. In case of a medical emergency, at least one first aider should be available within 5 minutes at all times. First aid training should be aligned with the needs of the site, e.g., specific training on chemical hazards and decontamination. The first aid trainer has to be certified according to local standards.

6.3 Emergency Treatment

At risk category B sites, there should be - in addition to the first aiders - at least one certified first responder available during normal working hours. First responders are persons with a medical education (e.g., nurse or paramedic) or at least an additional training that officially permits them to provide medical emergency treatment at a level above first aid, such as advanced trauma life support, advanced cardiac life support, advanced hazmat life support, psychosocial support and management of a MCI. First responders should update their skills annually.

At risk category A sites, at least one first responder must be available at all times.

At risk category A and B sites, medical emergency equipment (e.g., medication, antidotes, diagnostic devices, immobilization devices, triage equipment) must be available according to the existing risks and the skills and qualifications of the first responders.

At risk category A sites, at least one ambulance, with advanced life support capability, should be available on-site.

An automatic external defibrillator (AED) is required for risk category A and B sites. Risk category C sites require an AED if the external Emergency Medical Services response time is more than 15 minutes or if the EMS does not have advanced life support capability.

6.4 Measures in Case of Intoxications

In the event of a contamination or intoxication with a hazardous substance, information on the substance properties (such as material safety data sheets, chemical emergency medical guidelines) must be provided promptly to first responders, emergency medical services (EMS) and treating physicians. Medical staff should be trained in managing such events, including how to use antidotes. If there is risk of exposure to hazardous substances which may require treatment in hospital, medical emergency preparedness should include information sharing, training and cooperation with the relevant hospitals.

7. Documentation, Evaluation and Assessment

7.1 Medical Records

Individual medical files should be kept on each employee. All existing medical information should be stored in this individual medical file.

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The following contents are required:

- Medical history
- History of health habits (e.g., cigarette smoking, alcohol consumption)
- Occupational history
- Results of preplacement-, occupational surveillance- and general health examinations
- Documentation of consultations and first aid treatment
- Documentation of work-related diseases, accidents and intoxications

Medical Data Protection refer SOP-RC 4-4 Medical Data Protection

All medical information, including verbal communication, paper records, examination results, electronically stored information, photographs, X-rays, etc., should be generally classified as both “strictly confidential” and “sensitive personal”. This information should only be accessible to authorized medical personnel. Outcome of mandatory health surveillance examinations or fitness-to-work examinations should be transmitted by means of a certificate or written statement without disclosing confidential medical information, not pertinent to describe the employees’ ability to safely and reliably perform their job duties. Medical information cannot be disclosed without the consent of the concerned patient/employee. Where further disclosure is mandated, e.g., by legal regulations, medical personnel must notify the patient/employee in advance. Medical data protection procedures on-site should be transparent to all employees. Each employee has the right to receive a copy of his/her medical data records.

7.2 Medical Logbook

All first aid and medical emergency treatment have to be documented in a standardized form. This can be organized by a documentation form in the first aid kit or in a logbook in the site clinic or first aid treatment room. Should the patient/employee require further treatment (e.g., in an external clinic), the documentation should be provided to the medical staff providing further treatment, and a copy should be stored on-site.

7.3 Evaluation and Assessment

The periodic examinations of the workforce as a whole can be analyzed anonymously in relation to the specific workplaces and exposures in order to identify possible effects of workplace hazards at an early stage and to ensure a seamless health protection plan. If available, electronic data processing should be used to ensure accuracy of the analysis. The methodology of the analysis must be designed such that it is impossible to retrace and identify individual results. A report of the analysis and recommendations should be shared with the site management and safety team.

There should be a root cause analysis involving the SOHP for all occupational diseases and other workplace related health conditions. The SOHP is responsible for the medical aspects and management of confidential data.

7.4 Annual Report

All activities of the site’s occupational health department should be summarized in an annual report. If OH is managed by an external service provider the reporting should be done in collaboration with the site medical contact. The report should be communicated to the site management, workers’ representatives and the functional

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lead in occupational health (CCOHP or RCOHP).

This report should include:

- Overview of the general health status of the workforce
- The HPI-relevant figures
- Goals and achievements
- Proposals on how to further promote health, wellbeing and productivity on site

Additional elements can be:

- Site specific KPIs
- First aid cases
- Medical emergency treatments
- Number of return-to-work cases and medical restrictions
- Specific health promotion activities
- Organizational changes

8 Health Risk management and Industrial Hygiene

8.1 Health Risk Management

Health risk management follows the P-D-C-A Cycle. A health risk assessment is to be conducted at all workplaces to determine significant health hazards. Line management is responsible for implementation of a structured and systematic risk-based approach that is supported by experts i.e., EHS, IH and OH physicians. Categories of hazards to be assessed during risk assessment are:

- Chemical hazards
- Biological hazards
- Physical hazards
- Ergonomics
- Psychomental hazards

If the risk of exposure is significant, regular monitoring programs are required.

If the results of these monitoring exceed the threshold limit values or action thresholds, all stakeholders should collaborate to evaluate the need for corrective actions. The results of the workplace monitoring should be available for the OH staff. Any relevant changes in the workplace setting should also trigger a re-evaluation as part of a management of change process.

According to the hierarchy of controls the following measures should be part of health risk management:

- Substitution of hazardous substances
- Implementation or improvements of technical measures
- Change of the work organization
- Availability and use of personal protective equipment (PPE)

The results of the risk assessment in the workplace are subject to a continuous improvement process. In this context exposure measurements and assessments are utilized to check the efficiency of control measures on a regular basis.

In general, standard hygiene measures shall be taken at all times when handling Hazardous Substances, e.g., no eating and drinking in the workplace, suitable provision of changing and washing facilities as well as skin

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protection measures. There should be sufficient washing, shower facilities and changing rooms. The hygienic conditions of these facilities should encourage the workers to follow high standards of occupational and personal hygiene. The location and design of the social rooms should consider to avoid potential contamination from production areas.

All employees must have suitable and sufficient information, instruction and training to reliably control the risks in the workplace:

- Before starting their first activities
- In the case of changes
- Periodically, e.g., annually

Trainings should be supported by professionals knowledgeable in the respective hazards.

Standard Operating Procedures must include relevant information on safety and health risks and corresponding workplace- and/or activity-specific measures. All information must be clear and readily accessible to workers and shall include, at a minimum, safe steps to perform tasks, hazard and substance information and PPE requirements.

The standardized health risk assessment is also the basis for the design of the medical surveillance programs. All workplaces with the same health hazards and job requirements built one harmonized exposure group. There should be a health surveillance matrix that shows the required examinations for the different exposure groups. Relevant findings from periodic examinations and plant inspections should be considered when revising the health risk assessment.

After an emission event or product release there is the need for reliable information on human toxicity and health effects of the involved substances. Therefore, relevant experts i.e., EHS, IH, OH should be strategically integrated in concepts to manage these situations.

8.2 Safe Handling of Hazardous Substances

The management of risks related to handling of chemicals is crucial for BASF as a global chemical company. Therefore, a structured and systematic risk-based approach has to be implemented to prevent unacceptable exposure of employees working with Hazardous Substances. Prior to using Hazardous Substances, the following provisions must be assured:

- All Hazardous Substances to be used and their properties have been identified and documented
- Resulting risks in the workplace have been assessed. This concerns especially the route and level of exposure
- Adequate control measures have been defined and implemented following the hierarchy of controls
- Employees have been instructed about the identified hazards, risks and the protective measures to be taken

It shall be guaranteed that all used Hazardous Substances can be adequately identified in the workplace. The type and extent of the Hazardous Substance Identification and Communication have to be defined throughout the risk assessment process consistent with existing national regulations and have to be defined in regional documents.

Inventory of Hazardous Substances

The documentation of Hazardous Substances shall include raw materials, products, isolated intermediates, by-products and auxiliary materials. This includes process-generated waste gases, effluents or residues. Substance-specific data such as classification and labeling information can be taken either from the Safety Data Sheet or from different valid databases, preferably however, from BASIS, the global database for product safety data within BASF group.

All identified Hazardous Substances shall be listed in a facility specific inventory. The inventory of Hazardous

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Substances contains at least the following information for each chemical:

- Substance name and where appropriate identification number (e.g., CAS number, BASF identification number such as BI or PBG)
- Hazardous properties, i.e., classification and labeling information

The Hazardous Substances inventory is to be reviewed regularly and modified in the event of relevant changes (e.g., change of classification). Warehouse lists may be used if they fulfill the provisions as outlined above.

Risk Assessment in the Workplace

Risk assessment consists basically of two elements, a qualitative and a quantitative assessment according to the risk potential of the chemical concerned and the nature of the operation.

The risk of workplace exposure to hazardous chemicals must be identified and assessed with reference to the chemical inventory, tasks, and working areas. Routine and non-routine activities including maintenance, cleaning operations and changes in production cycles, e.g. start-up or shut-down of facilities, are to be included.

Production-related spills and equipment leaks may be included when appropriate as determined in the risk assessment.

The following routes of exposure are to be evaluated:

- Inhalation
- Skin contact
- Ingestion

The Exposure Assessment shall take into account not only the substance properties (specified by the classification and physical parameters) but also process-related factors as:

- Type, frequency, duration and physical setting of activities and the related level of exposure
- Process parameters as temperature and/or pressure
- Technical equipment including existing risk management measures and
- Personal protective equipment already in use

The assessment is to serve as a tool to identify potential health risks to personnel working with Hazardous Substances and to differentiate between acceptable and unacceptable exposures. It also serves as guidance to control unacceptable exposures by control measures like engineering controls, administrative controls, or use of PPE.

Once a characterization of employee's exposure has been completed, industrial hygiene, medical, and engineering resources can be effectively allocated to reduce employee health risks. This includes effective implementation of control measures, identifying employee training needs and improved execution of medical surveillance programs.

Non-routine operations, which are covered by safe work practice standards (e.g., line breaking, confined space entry, etc.), and emergency conditions are not specifically addressed in this process; however, the concepts for qualitative and quantitative assessments may be applied during these situations.

Based on the outcome of the qualitative risk assessment, a quantitative assessment may be required. Typically, this would include activities with increased exposure potential, such as filling and de-canting, sampling, filter change, cleaning activities, maintenance and repair work.

The sampling strategy will specify the Hazardous Substances to be monitored, the frequency and methodology of the measurement.

Results from sampling programs shall be evaluated considering national applicable OEL values. If a result exceeds the OEL, the following measures shall be considered to improve risk management.

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- Improve or implement new engineering controls
- Improve standard operating procedures and work practices
- Verify proper use of adequate PPE
- Implement a health/medical surveillance program

The effectiveness of the improvement shall be verified.

The results of the exposure measurements are to be managed and communicated according to regional BASF record retention and communication policies.

8.3 Personal Protective Equipment

Workplaces where personal protective equipment (PPE) is mandatory should be clearly indicated. PPE should be of good quality, stored properly, undergo regular maintenance or exchange and if necessary replaced.

If PPE is used, a personal protective equipment program is to be implemented. This includes regular information and training of workers how to use PPE. Additional information is given in G-P-OSA 020 "Respiratory Protection".

Sufficient working clothes should be provided clean and in good quality. Contamination of private clothes and clean working clothes through used PPE or dirty working clothes has to be avoided. Ideally, there is a separation of clean and dirty working clothes by using different lockers.

8.4 Ergonomics

The SOHP should identify risk factors for musculoskeletal disorders at various workplaces and share these data with Occupational Safety. A standardized protocol or established evaluation method should be used. The method should cover:

- Heavy, frequent or awkward lifting
- Repetition (highly repetitive motions)
- Sustained or awkward postures
- Force (high or sudden)
- Moderate to high hand-arm vibration
- Office ergonomics
- Other physical exposures, i.e., light intensity, heat, cold, humidity, etc.

The SOHP should also be consulted with regard to the ergonomic design of new workplaces.

Secondary preventive measures such as providing beverages, organizing job rotation and breaks should be implemented if appropriate.

9. Retention Records

The result of medical examination of all employees shall be kept for period of their employment and at least 30 years after resignation.

Related Document

- SOP-RC 4-2 Medical Emergency Preparedness and First Aid
- SOP-RC 4-3 Reproductive Health
- SOP-RC 4-4 Medical Data Protection
- SOP-RC 4-6 Pandemic Preparedness Planning Manual

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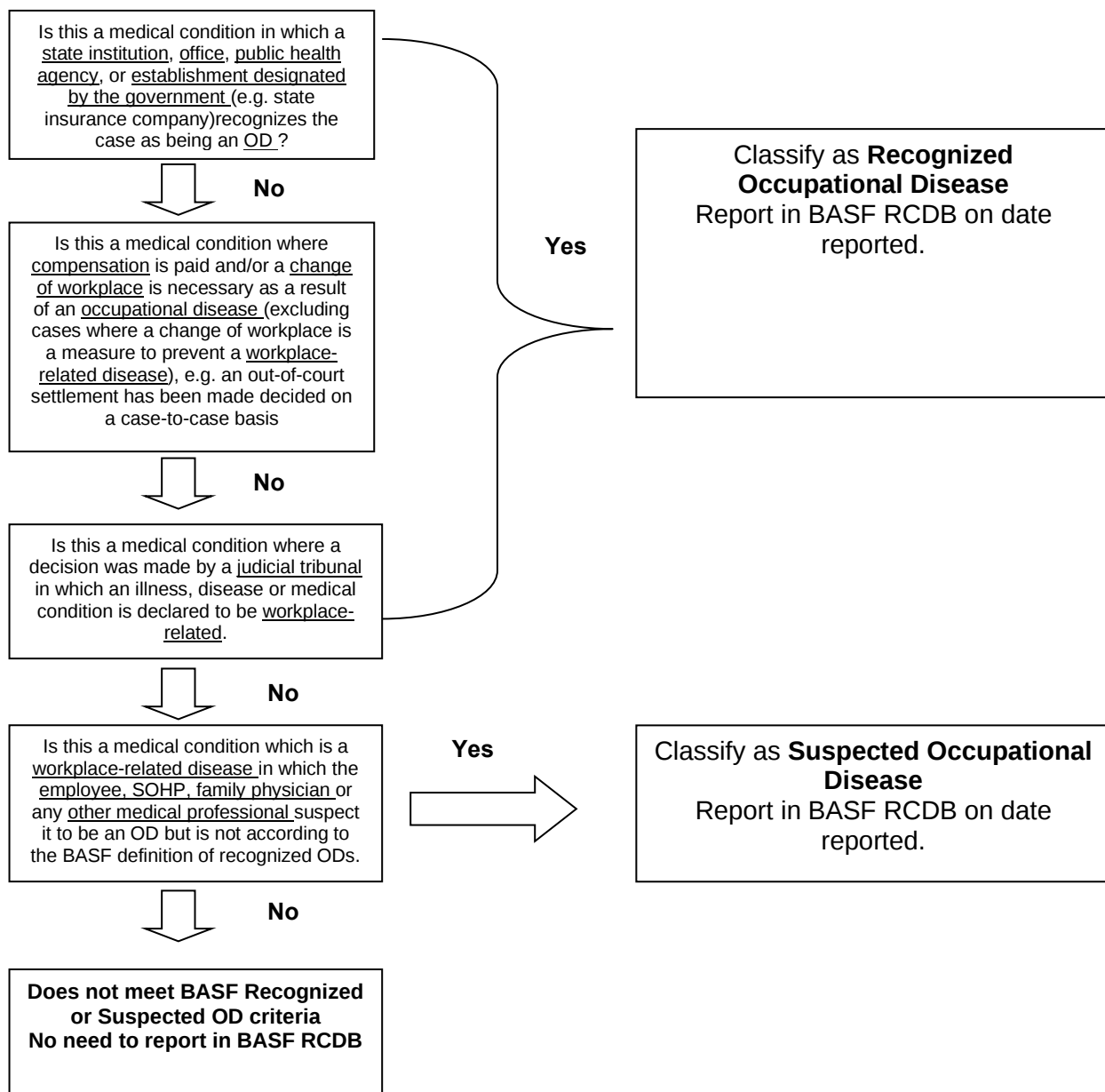
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- SOP-RC 4-7 Health Management for BASF Business Travelers and Transferees
- SOP-RC 4-8 Occupational Skin Diseases - Recognition and Prevention

Form

- F-RC 4-5 Fitness to work certification

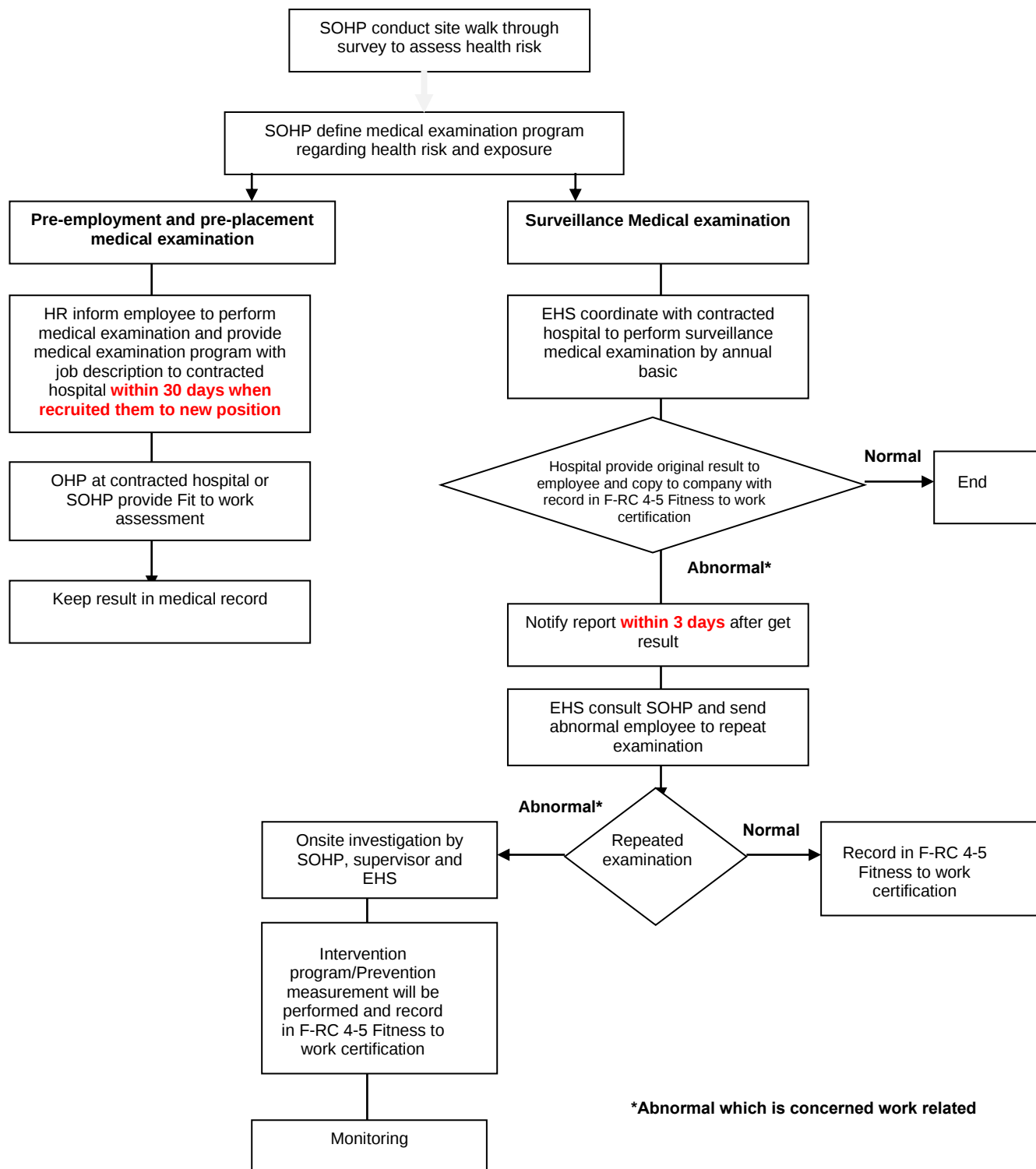
Annex 1 : BASF Occupational Disease (OD) Classification and Reporting



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Annex 2: Medical Examination flow



*Abnormal which is concerned work related

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Annex 3: The requirement of Medical examination

A. Medical examination Program for Emporium office

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
General Examination			
1	Medical examination (BMI, Blood Pressure, Pulse rate)	/	/
2	CBC (Complete Blood Count)	/	/
3	Blood Group (A, B, O and Rh)	/	-
4	Urine analysis	/	/
5	FBS (Fasting Blood Sugar)	/	The employee who have 35 years old up
6	BUN, Creatinine (Kidney Function Test)	/	/
7	Lipid Profile (Cho, TG, HDL, LDL)	/	The employee who have 35 years old up
8	Liver Function Test (SGOT, SGPT, AP)	/	/
9	HBS Ag, Anti HBS	/	-
10	Chest X-ray (Big Film)	/	/
11	EKG	the employee who have 35 years old up	the employee who have 35 years old up
12	PAP Smear*	-	For the women marriage and/or women employee who have 35 years old up
13	Prostatic Specific Antigen (PSA)*	-	For the men employee who have 45 years old up
14	Fecal occult blood test*	-	For employees older than 45 years.
Occupational Health Examination			
15	Occupational Visual Test (Visual acuity, depth perception and visual field test)	/	Every year for company's driver and every 3 years for office staff
18	EKG	Specific for Fire Fighting Team	Specific for Fire Fighting Team
19	Audiometry	Company's driver and receptionist	Every 3 years for company's driver and receptionist

/ = All employee

Remark : * is voluntary program

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B.Medical examination Program for SAP Rayaong site

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
General Examination			
1	Medical examination (BMI, Blood Pressure, Pulse rate)	/	/
2	CBC (Complete Blood Count)	/	/
3	Blood Group (A, B, O and Rh)	/	-
4	Urine analysis	/	/
5	FBS (Fasting Blood Sugar)	/	The employee who have 35 years old up
6	BUN, Creatinine (Kidney Function Test)	/	/
7	Lipid Profile (Cho, TG, HDL, LDL)	/	The employee who have 35 years old up
8	Liver Function Test (SGOT, SGPT, AP)	/	/
9	HBS Ag, Anti HBs	/	-
10	ANT-HAV IG G	/	-
11	Chest X-ray (Big Film)	/	/
12	PAP Smear*	-	For the women marriage and/or women employee who have 35 years old up
13	Prostatic Specific Antigen (PSA)*	-	For the man who have 45 years old up
14	Fecal occult blood test*	-	For employees older than 45 years old up
15	Urine Amphetamine	/	/
Occupational Health Examination			
16	Occupational Visual Test (Visual acuity, depth perception and visual field test)	/	/
17	Pulmonary Function Test	For employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)	For employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)
18	EKG	For all shift workers in Operations Department including Maintenance Specific for Fire Fighting /Hazmat Team The employee who have 35 years old up and employee who could be work in confined space (Rescuer and Worker)	For all shift workers in Operations Department including Maintenance Specific for Fire Fighting /Hazmat Team The employee who have 35 years old up and employee who could be work in confined space (Rescuer and Worker)
19	Methanol in urine	Specific for QA LAB by examination at end of shift	Specific for QA LAB by examination at end of shift
20	Exercise Stress Test (every 3 years) stress ECG for emergency response team members 1.8-2.1 W/kg at a heart rate of 150/min.	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA)	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA) every 3 year
21	Audiometry	For employee who could be exposed to noise (> 80 dBA) and Forklift Operator and company's driver and receptionist	For employee who could be exposed to noise (> 80 dBA) And Forklift Operator Every 3 years for company's driver and receptionist
22	Methylene chloride in Urine after shift	Specific for QA LAB	Specific for QA LAB

/= All employee

Remark : * is voluntary program

Methanol and Methylene chloride in urine will be checked for Hazmat team in case of emergency

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C. Medical examination Program for Bangpoo site

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
General Examination			
1	Medical examination (BMI, Blood Pressure, Pulse rate)	/	/
2	CBC (Complete Blood Count)	/	/
3	Blood Group (A, B, O and Rh)	/	-
4	Urine analysis	/	/
5	FBS (Fasting Blood Sugar)	/	The employee who have 35 years old up
6	BUN, Creatinine (Kidney Function Test)	/	/
7	Lipid Profile (Cho, TG, HDL, LDL)	/	The employee who have 35 years old up
8	Liver Function Test (SGOT, SGPT, AP)	/	/
9	HBS Ag, Anti HBs	/	-
10	Chest X-ray (Big Film)	/	/
11	PAP Smear*	-	For the women marriage and/or women employee who have 35 years old up
12	Prostatic Specific Antigen (PSA)*	-	For the man who have 45 years old up
13	Fecal occult blood test*	-	For employees older than 45 years
14	Urine Amphetamine	/	/
Occupational Health Examination			
15	Occupational Visual Test (Visual acuity, depth perception and visual field test)	/	/
16	Pulmonary Function Test	For employee who could be exposed - respirable dust is >10mg/m3 - Diisocyanate chemical (TDI, MDI) - Aluminium oxide - Barium Sulfate - Butyl acrylate - Ethyl acetate - Isobutyl acetate - Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, - For employee who could be exposed to welding activity, engineering and maintenance - Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)	For employee who could be exposed - respirable dust is >10mg/m3 - Diisocyanate chemical (TDI, MDI) - Aluminium oxide - Barium Sulfate - Butyl acrylate - Ethyl acetate - Isobutyl acetate - Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, - For employee who could be exposed to welding activity, engineering and maintenance - Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)
17	EKG	Specific for Fire Fighting/Hazmat Team The employee who have 35 years old up For Employee who could be work in Confined Space (Rescuer and Worker)	Specific for Fire Fighting/Hazmat Team The employee who have 35 years old up For Employee who could be work in Confined Space (Rescuer and Worker)
18	Exercise Stress Test (every 3 years) stress ECG for emergency response team members 1.8-2.1 W/kg at a heart rate of 150/min.	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA) every 3 year	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA) every 3 year
19	Audiometry	For employee who could be exposed to noise (> 80 dBA) Forklift Operator And company's driver and receptionist	For employee who could be exposed to noise (> 80 dBA) Forklift Operator Every 3 years for company's driver and receptionist
20	Methanol in urine	PM QA/QC LAB and Technical Service and EC production by examination at end of shift	PM QA/QC LAB and Technical Service and EC production by examination at end of shift

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Medical examination Program for Bangpoo site (continue)

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
Occupational Health Examination			
21	Isocyanate Medical surveillance program	Fill in Questionnaire I – Medical Interview (Pre-placement Examination) For employee who could be exposed to Diisocyanate chemical (TDI, MDI) Production QA/QC Lab, Technical Service	-
22	Isocyanate Medical surveillance program* (3 months after employment, thereafter Annually)	-	Fill in Questionnaire II – Medical Interview (Periodic Examination) For employee who could be exposed to Diisocyanate chemical (TDI, MDI) Production QA/QC Lab, Technical Service
23	Urine ortho-cresol / Toluene in Urine	Specific for laboratory technicians who may expose toluene by examination at end of shift	Specific for laboratory technicians who may expose toluene by examination at end of shift
24	Methylhippuric acid in urine - xylene	Specific for EC laboratory technicians who may expose xylene by examination at end of shift .	Specific for EC laboratory technicians who may expose xylene by examination at end of shift .
25	Methoxyacetic acid in urine	Specific for EC who may expose 2-Methoxy-1-Methylethyl Acetate	Specific for EC who may expose 2-Methoxy-1-Methylethyl Acetate
26	Acetone	Specific for PM who may expose Acetone	Specific for PM who may expose Acetone
27	S-Phenylmercapturic acid (SPMA) in urine	Specific for EC who may expose Benzene	Specific for EC who may expose Benzene
28	Σ Mandelic acid (MA) + Phenylglyoxylic acid (PGA) urine	Specific for EC who may expose Ethylbenzene	Specific for EC who may expose Ethylbenzene
31	Methyl Isobutyl Ketone urine	Specific for EC who may expose Methyl Isobutyl Ketone	Specific for EC who may expose Methyl Isobutyl Ketone
32	Σ Naphthols urine	Specific for EC who may expose Naphthalene	Specific for EC who may expose Naphthalene
33	1-Butanol urine	Specific for EC who may expose n-Butanol	Specific for EC who may expose n-Butanol
34	Σ Mandelic acid (MA) + Phenylglyoxylic acid (PGA) urine	Specific for EC who may expose Styrene	Specific for EC who may expose Styrene

/ = All employee

Remark : * is voluntary program

Methanol and ortho-cresol and Methylhippuric acid and Methoxyacetic acid and Acetone and S-Phenylmercapturic acid (SPMA) and Σ Mandelic acid (MA) + Phenylglyoxylic acid and Methyl Isobutyl Ketone and Σ Naphthols and 1-Butanol and Σ Mandelic acid (MA) + Phenylglyoxylic acid (PGA) in urine will be checked for Hazmat team in case of emergency

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D. Medical examination Program for BCTL site

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
General Examination			
1	Medical examination (BMI, Blood Pressure, Pulse rate)	/	/
2	CBC (Complete Blood Count)	/	/
3	Blood Group (A, B, O and Rh)	/	-
4	Urine analysis	/	/
5	FBS (Fasting Blood Sugar)	/	The employee who have 35 years old up
6	BUN, Creatinine (Kidney Function Test)	/	/
7	Lipid Profile (Cho, TG, HDL, LDL)	/	The employee who have 35 years old up
8	Liver Function Test (SGOT, SGPT, AP)	/	/
9	HBS Ag, Anti HBs	/	-
10	Chest X-ray (Big Film)	/	/
11	PAP Smear*	-	For the women marriage and/or women employee who have 35 years old up
13	Prostatic Specific Antigen (PSA)*	-	For the men employee who have 45 years old up
14	Fecal occult blood test*	-	For employees older than 45 years.
15	Urine Amphetamine	/	/
Occupational Health Examination			
16	Pulmonary Function Test	Employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, and chemical Slurry, Coating, QA/QC, Engineering and Maintenance, Warehouse, Safety Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)	Employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, and chemical Slurry, Coating, QA/QC, Engineering and Maintenance, Warehouse, Safety Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (SCBA)
17	EKG	The employee who have 35 years old up Specific for Fire Fighting/ Hazmat Team For Employee who could be work in Confined Space	The employee who have 35 years old up Specific for Fire Fighting/ Hazmat Team For Employee who could be work in Confined Space
18	Exercise Stress Test (every 3 years) stress ECG for emergency response team members 1.8-2.1 W/kg at a heart rate of 150/min.	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA)	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA) every 3 year
19	Audiometry	For employee who could be exposed to noise (> 80 dBA) and company's driver and receptionist	For employee who could be exposed to noise (> 80 dBA) Every 3 years for company's driver and receptionist
20	Nickel in Urine by keeping examination at end of shift.	Production who expose nickel	Production who expose nickel

/ = All employee

Remark : * is voluntary program

Nickel in urine will be checked for Hazmat team in case of emergency

BASF Group in Thailand

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E. Medical examination Program for Bangpakong site

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
General Examination			
1	Medical examination (BMI, Blood Pressure, Pulse rate)	/	/
2	CBC (Complete Blood Count)	/	/
3	Blood Group (A, B, O and Rh)	/	-
4	Urine analysis	/	/
5	FBS (Fasting Blood Sugar)	/	The employee who have 35 years old up
6	BUN, Creatinine (Kidney Function Test)	/	/
7	Lipid Profile (Cho, TG, HDL, LDL)	/	The employee who have 35 years old up
8	Liver Function Test (SGOT, SGPT, AP)	/	/
9	HBS Ag, Anti HBs	/	-
10	Chest X-ray (Big Film)	/	/
11	PAP Smear*	-	For the women marriage and/or women employee who have 35 years old up
12	Prostatic Specific Antigen (PSA)*	-	For the men employee who have 45 years old up
13	Fecal occult blood test*	-	For employees, older than 45 years old up.
14	Urine Amphetamine	/	/
Occupational Health Examination			
15	Occupational Visual Test (Visual acuity, depth perception and visual field test)	/	/
16	Pulmonary Function Test	Employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, and chemical Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (Airline and SCBA)	Employee who could be exposed to dust especially if air concentration for respirable dust is >10mg/m3, and chemical Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces, For employee who could be exposed to welding activity, engineering and maintenance Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (Airline and SCBA)
17	EKG	The employee who have 35 years old up Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces (Rescuer and Worker)	The employee who have 35 years old up Specific for Fire Fighting/Hazmat Team and employee who work in confined Spaces (Rescuer and Worker)
18	Methanol in urine	-	Specific for laboratory technicians, MPR who may expose methanol by examination at end of shift.
19	Exercise Stress Test (every 3 years) stress ECG for emergency response team members 1.8-2.1 W/kg at a heart rate of 150/min.	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (Airline and SCBA)	Specific for Fire Fighting/Hazmat Team Worker use Respirator with compressed air (SCBA) every 3 year
20	Audiometry	For employee who could be exposed to noise (> 80 dBA) Forklift operator and company's driver and reception/Operator	For employee who could be exposed to noise (> 80 dBA) Forklift operator Every 3 years for company's driver and reception/operator

BASF Group in Thailand

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Medical examination Program for Bangpakong site (con't)

No	Parameters	Pre-employment / Pre-placement medical examination	Surveillance medical examination
Occupational Health Examination			
21	Acetone in urine	-	Employees who could be exposed to Acetone Laboratory technicians, QC Lab staffs, EMD-FT Lab staffs and Waste operator Employees who could be exposed to isopropyl alcohol (2-propanol or IPA). QM&OMPP Lab staffs, SO3 operator, Waste operator and filling W/H
22	2,5 hexanedion in urine	-	Employees who could be exposed to hexane QC lab staffs
23	Styrene in urine by keeping examination at end of shift	-	Employee who could be exposed to Styrene Laboratory technicians
24	Mercury in urine by keeping examination at end of shift.	-	Employee who could be exposed to Mercury Technicians in utility laboratory
25	Lead in blood	-	Employee who could be exposed to Lead (II) nitrate QC laboratory
26	Total chromium in urine at end of shift	-	Employee who could be exposed to chromium in Utility Lab

/ = All employee

Remark: * is voluntary program

Methanol and Acetone and 2,5 hexanedion and Styrene and Mercury and Lead and Total chromium will be checked for Hazmat team in case of emergency

BASF Group in Thailand

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F: Pre-employment and Surveillance Medical Examination Program for Long Term Contractor

N o.	Parameter	Security and checker	Maid and gardener	Food Handlers	Engineering Long-term contractor
Occupational Health Examination (Mandatory)					
1	Visual acuity, depth perception and visual field test	No	No	No	/
2	EKG	No	No	No	/ Work in confined Spaces (Rescuer and Worker)
3	Pulmonary Function Test	No	No	No	/ For employee who could be exposed to especially if air concentration for respirable dust is >10mg/m3, welding activity, engineering and maintenance and Employee who work in confined space, Worker use Respirator when the weight of the respirator is more than 3 kg and/or the breathing resistance is higher than 5 mbar (Airline and SCBA)
4	Audiometry (noise level > 80 dBA) & for fitness to work reasons (such as in car driver and forklift driver's groups)	No	No	No	/
5	Chest X-ray (Big Film)	No	No	Yes for TB	/
6	Stool test for pathogenic organisms	No	No	Yes	No
8	Urine Amphetamine	/	/	/	/
General Examination (Optional)					
1	Physical Examination (BMI, Blood Pressure, Pulse rate)	/	/	/	/
2	CBC (Complete Blood Count)	/	/	/	/
3	Urine analysis	/	/	/	/
4	BUN, Creatinine (Kidney Function Test)	/	/	/	/
5	Liver Function Test (SGOT, SGPT, AP)	/	/	/	/
6	Chest X-ray (Big Film)	/	/	/	/
7	FBS (Fasting Blood Sugar)	The employee who have 35 years old up	The employee who have 35 years old up	The employee who have 35 years old up	The employee who have 35 years old up
8	Lipid Profile (Cho, TG, HDL, LDL)	The employee who have 35 years old up	The employee who have 35 years old up	The employee who have 35 years old up	The employee who have 35 years old up

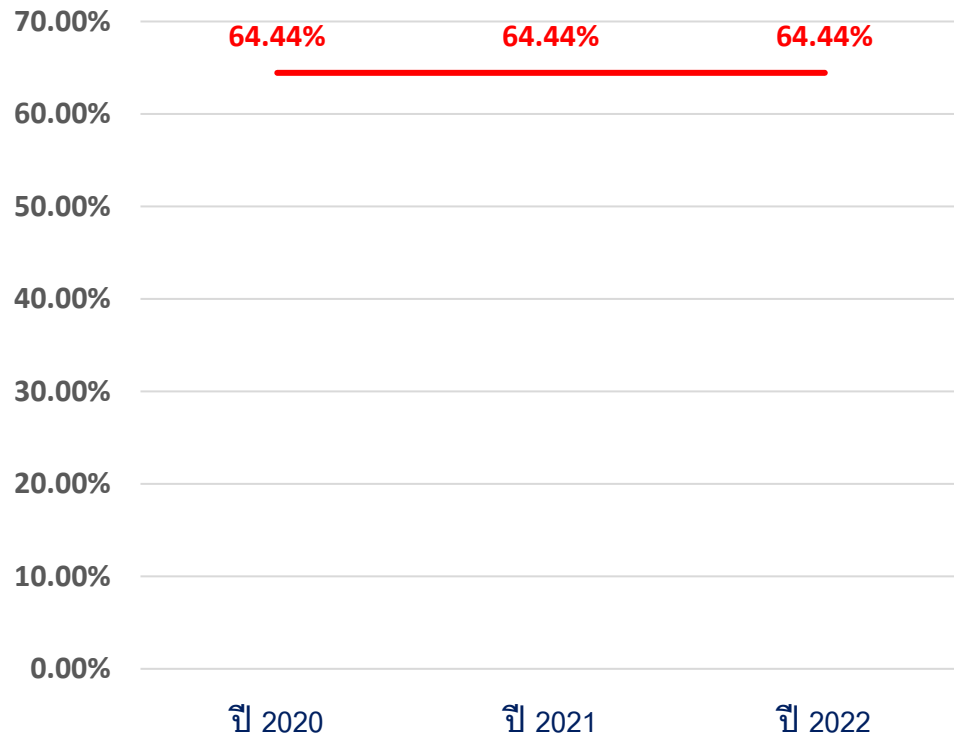
/ = All employee

Remark: * is voluntary program

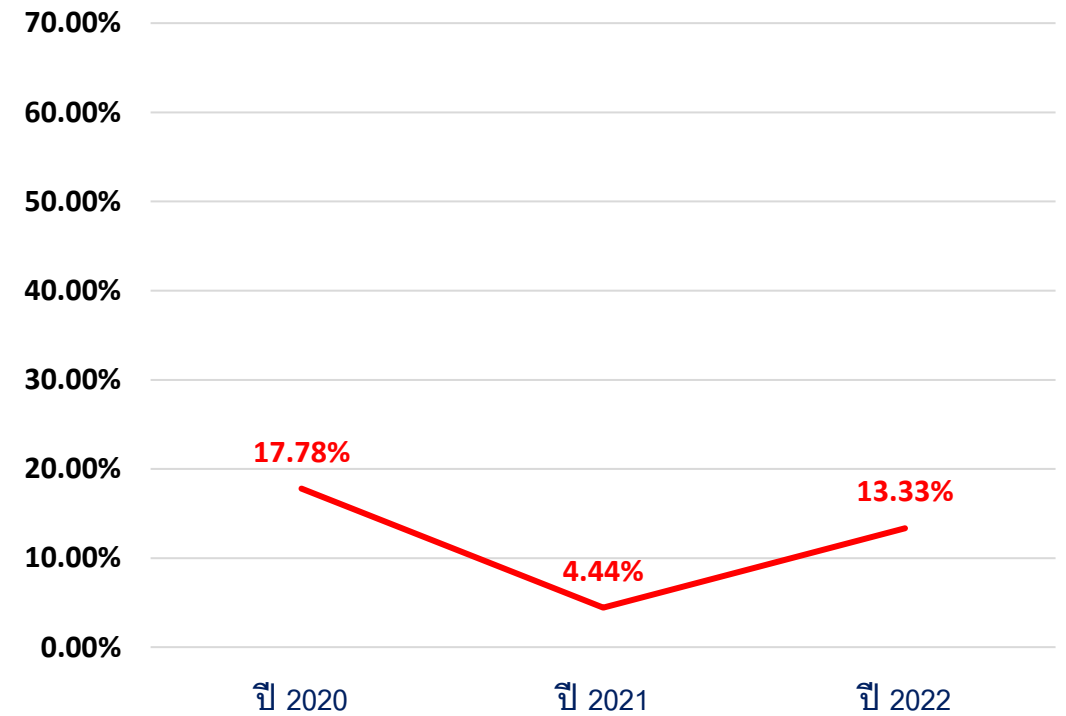
General health check up results

Abnormal

BMI



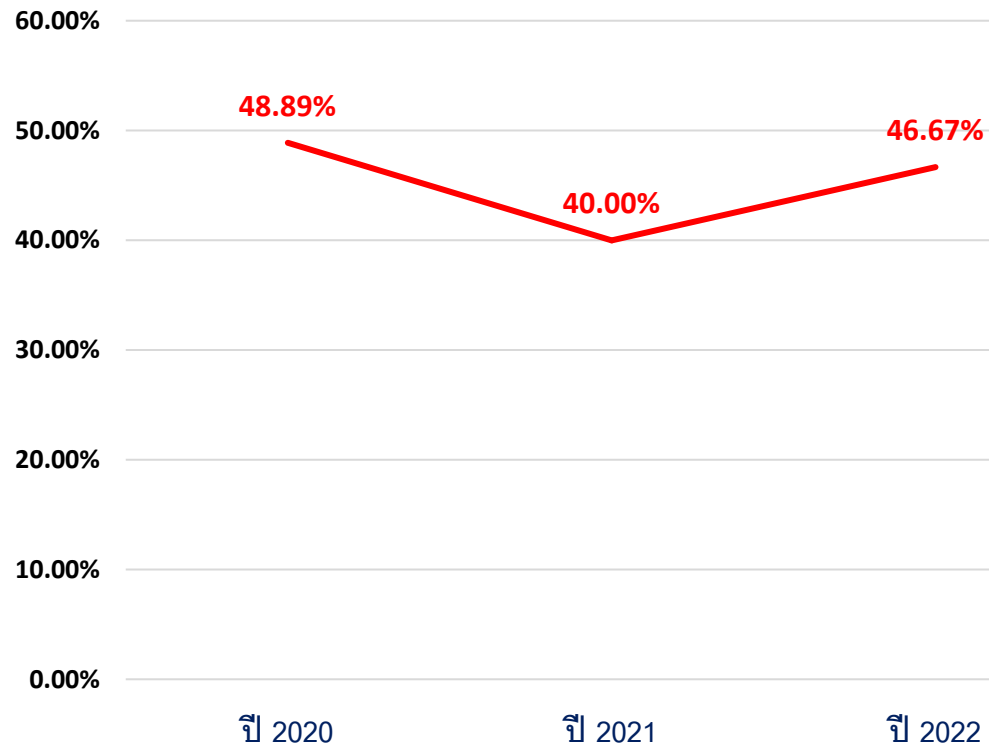
Blood Pressure



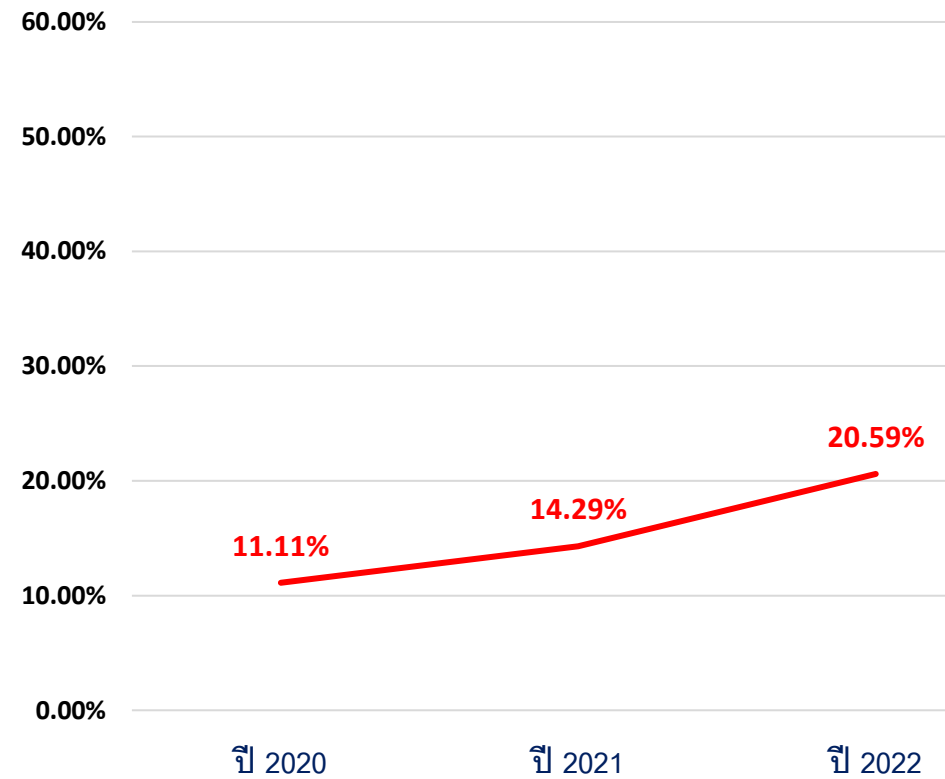
General health check up results

— Abnormal

Complete Blood Count



Blood Sugar



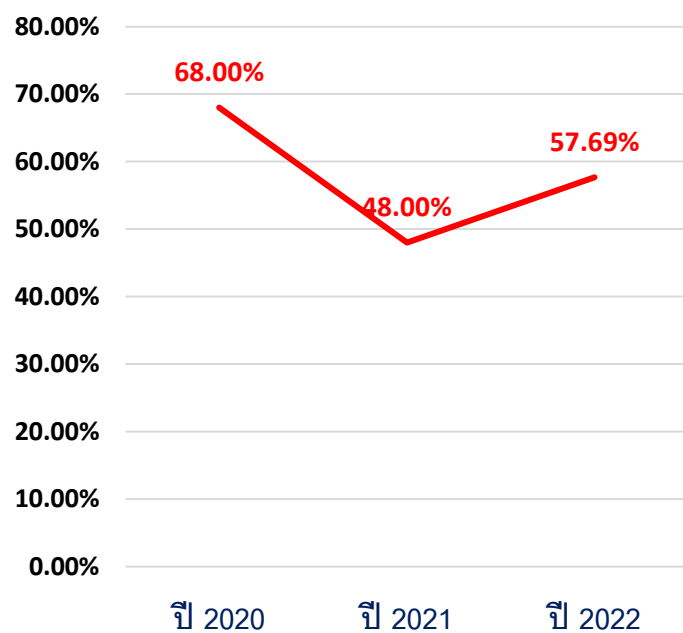
General health check up results

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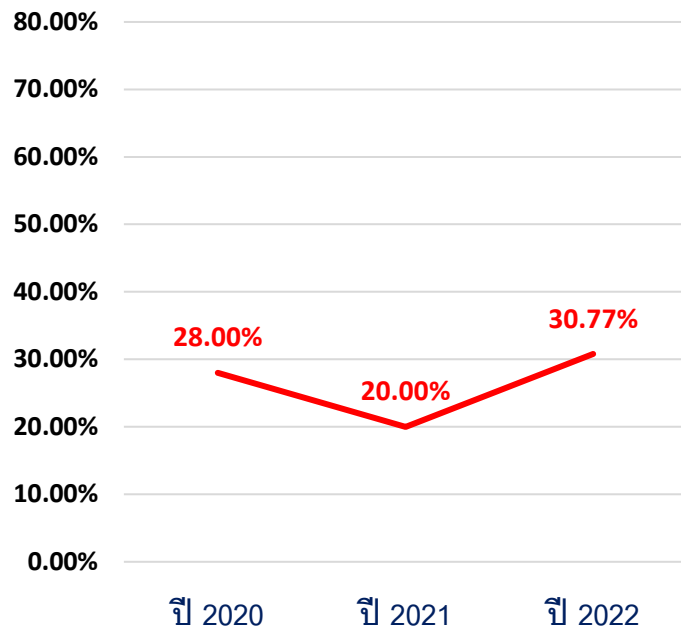
Lipid Profile



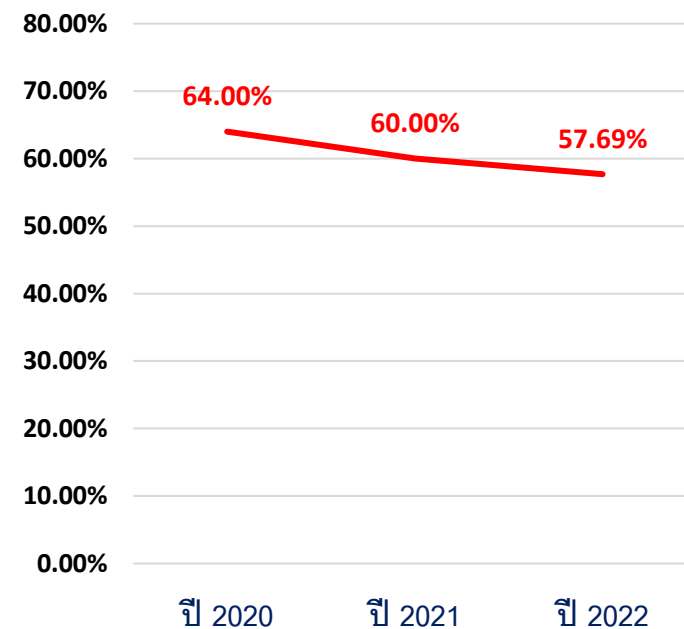
Cholesterol



Triglyceride



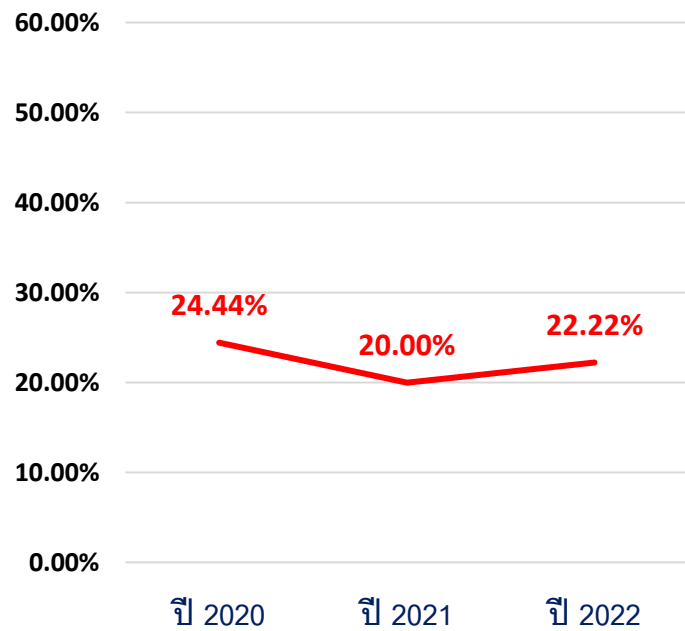
LDL



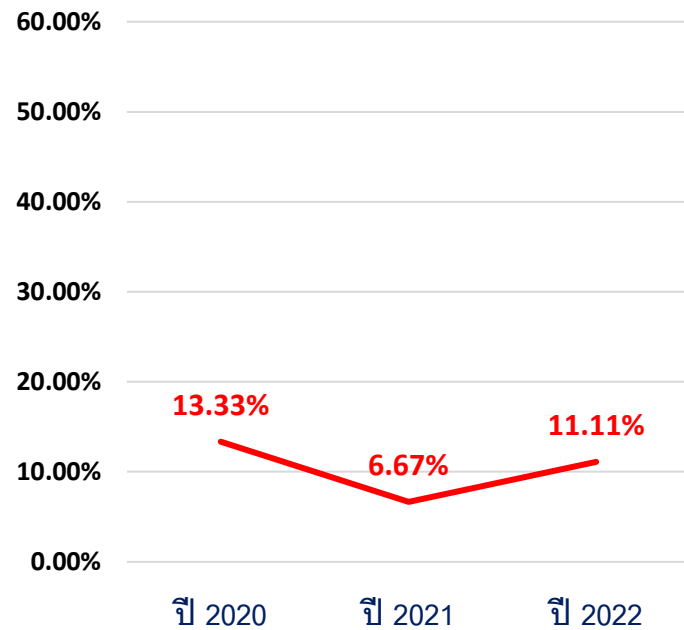
General health check up results

— Abnormal

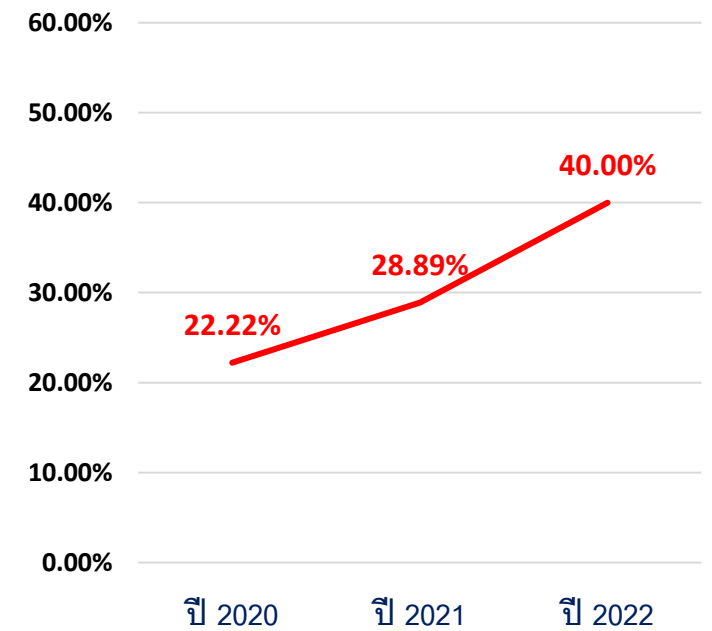
Liver function



Kidney function



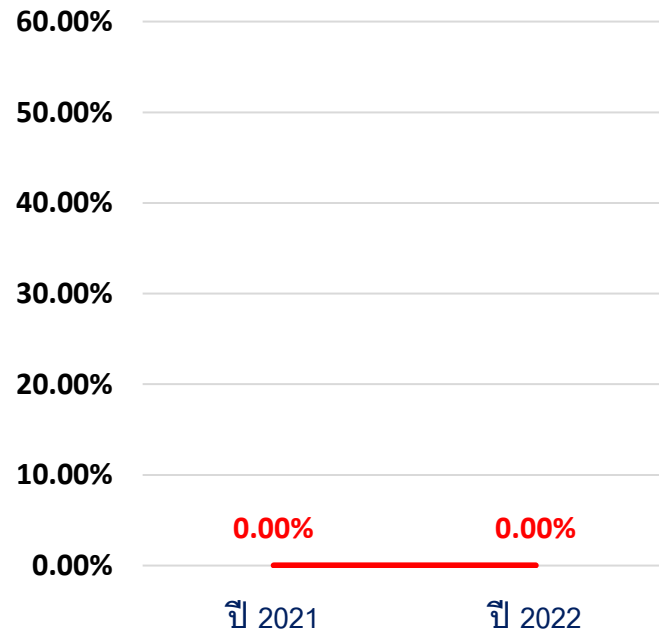
Urine examination



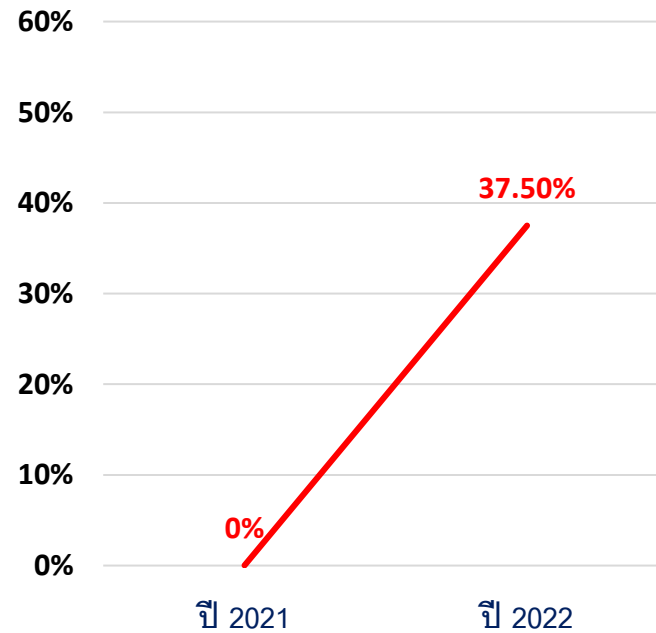
General health check up results

— Abnormal

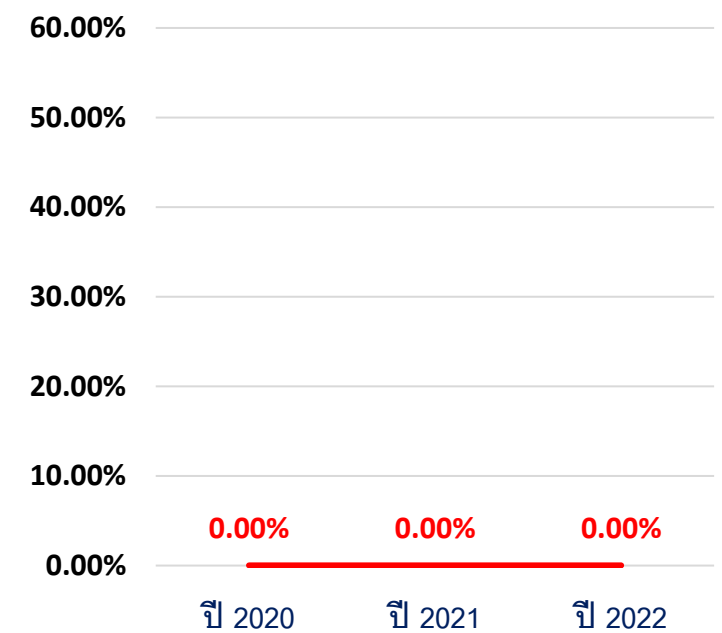
PSA



Stool occult blood



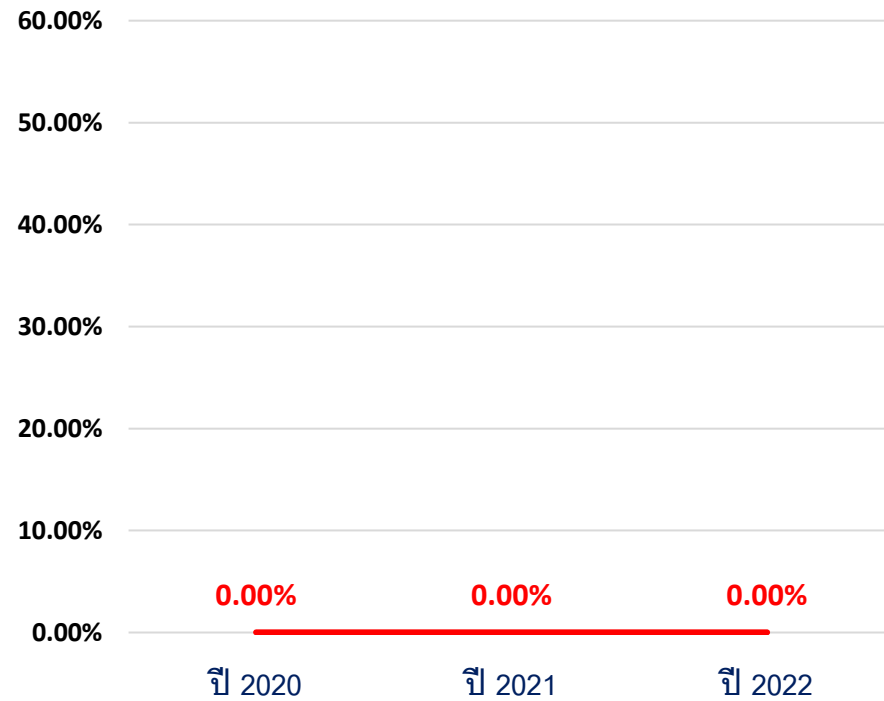
Exercise stress test



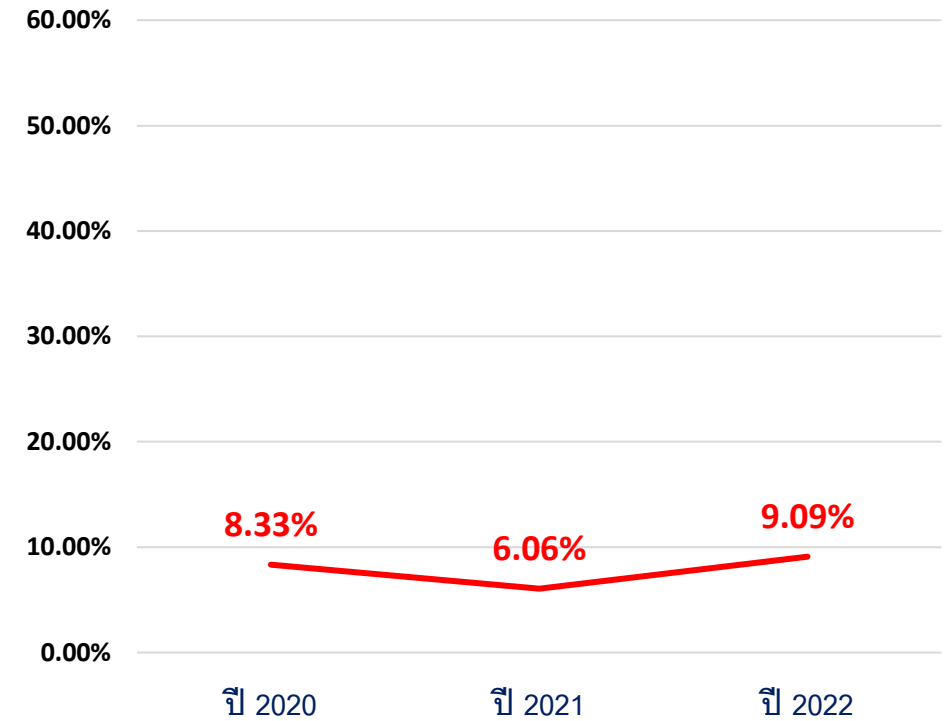
General health check up results

— Abnormal

CXR



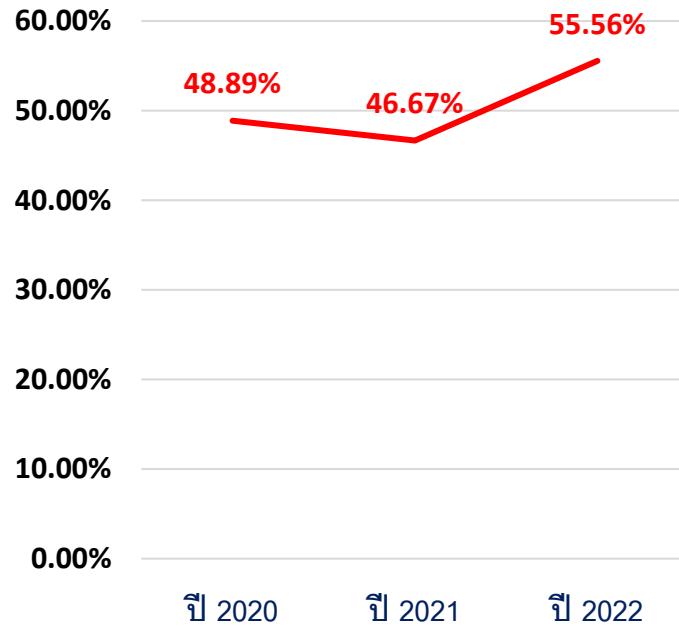
EKG



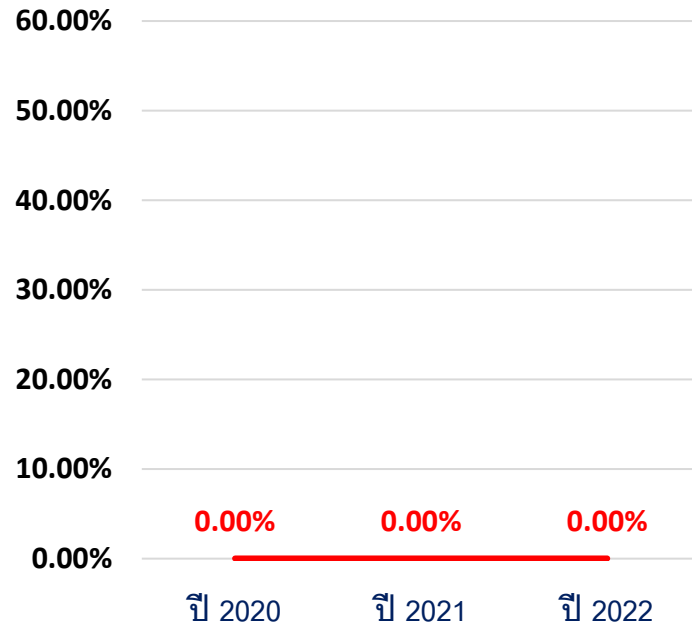
Risk based health check up results

— Abnormal

Occupational vision test



Biomarker



Audiometry

