2026 中国大学生 Chem-E-Car 竞赛规则

目录

为了完善中国大学生 Chem-E-Car 竞赛的管理体系，确保竞赛的公平公正，中国大学生 Chem-E-Car 竞赛委员会结合中国化工专业及相关领域学科竞赛需求，特对 2026 中国大学生 Chem-E-Car 竞赛官方规则做如下说明：

一、2026 中国大学生 Chem-E-Car 竞赛官方规则包括 2026 年中国区地区赛规则解释和 2026 AIChE Chem-E-Car 竞赛官方规则。

二、安全规则是中国大学生 Chem-E-Car 竞赛规则的重要组成部分，本年度使用 2026 AIChE Chem-E-Car 竞赛安全规则，请参赛队伍重视并认真贯彻落实。

一、2026 中国大学生 Chem-E-Car 竞赛官方规则

为了更好契合赛事精神和宗旨，中国大学生 Chem-E-Car 竞赛委员会根据中国赛区的特点，在 2026 AIChE Chem-E-Car 竞赛官方规则的框架下增加了数条规则解释。2026 中国大学生 Chem-E-Car 竞赛官方规则包括 2026 年中国区地区赛规则解释和 2026 AIChE Chem-E-Car 竞赛官方规则。请参赛队伍认真阅读并执行。

1.1 2026 年中国大学生 Chem-E-Car 官方规则的变化

以下变化参考 AIChE Chem-E-Car 官方规则进行修改

竞赛规则的修改：

a. 新增竞赛奖项(建模仿真奖)

附录变更内容如下：

a. 附录 A（3）：要求最大允许工作压力（MAWP）未知的容器需由商业公司对其 MAWP 进行认证，取消团队自行认证的选项。

EDP 模板的变更内容如下：

a. 危险检查表的压力部分已更新，以符合有关压力的规则变更，包括所有汽车部件的最大允许工作压力（MAWP）必须大于最大工作压力（MOP）的要求，以及承受压力的塑料管材需具备实际压力使用的制造文件的要求。

1.2 2026 中国大学生 Chem-E-Car 竞赛官方规则解释

1.参赛者为全日制高校在校本科生，需为中国化工学会学生会员。比赛以团队形式参加，每队不少于 5 人，不多于 15 人，设队长 1 人。每位学生只允许参加一支代表队，鼓励学生多学科组队参赛。

2.赛前文件提交：为了保证参赛方案的一致性，参赛队提交的最终参赛方案须与第二次提交的 EDP 文件一致，即第二次提交 EDP 文件后不能再修改方案。

3.小车制作：小车的驱动回路中不能存在测速装置、编码器及控制电压/电流的稳压器/稳流器。

4.竞赛准备：在起跑线处，不允许抱起小车空转或者抱起小车启动后再放回地面起跑。在实验准备区，如要检测电路和机械连接问题可拆掉轮胎进行电路测试，但不允许进行测速。

5.赛后检查：性能竞赛完成后，专家将对获得性能竞赛奖队伍的小车进行检查。在检查完毕之前，参赛队伍不得拆卸小车。如存在违规情况，则取消成绩。递补队伍的小车也需接受检查。

6.裁判设置：性能竞赛中将设置场内裁判，并在场外设置急救中心和临时应急裁判中心。场内裁判负责在场内巡视，若队伍有突发状况，场内裁判将报告给临时应急裁判中心，由临时应急裁判中心做出相应决策。

7.AIChE Chem-E-Car 全球赛资格：获得性能竞赛特等奖的两支队伍和东道主队伍可以获得当年的 AIChE Chem-E-Car 全球赛参赛资格。若当年的东道主队伍获得了性能竞赛特等奖，则同时推荐性能竞赛的第三名参加当年的 AIChE Chem-E-Car 全球赛。

8.中国大学生 Chem-E-Car 竞赛奖项设置：

（1）学生队伍获奖

- 性能竞赛：

特等奖（2 名）：性能竞赛特等奖
一等奖（4 名）：性能竞赛一等奖
二等奖（6 名）：性能竞赛二等奖

- 最佳使用生物反应为小车提供动力奖（评审组）
- 最佳安全奖：最佳应用化工过程安全原理的 2 支队伍（评审组）
- 竞赛精神奖：最具团队精神的队伍（评审组）
- 最佳设计奖：驱动系统最具创新的前 2 名队伍（评审组）
- 最佳海报奖：海报竞赛前 2 名的队伍（评审组）
- 杰出体育道德奖：最具有体育竞赛道德的队伍（评审组）
- 金轮胎奖：最有创意设计的小车队伍（所有参赛队投票）
- 最佳视频奖：视频竞赛前 2 名的队伍（所有参赛队投票）
- 最佳队名奖：参赛队伍名称最有创意的队伍（所有参赛队投票）
- 建模仿真奖：最佳应用建模仿真软件来进行小车设计的队伍（评审组）

（2）优秀指导教师奖

优秀指导教师奖：授予性能竞赛获得特等奖和一等奖的队伍指导教师团队

1.3 2026 AIChE Chem-E-Car 官方规则

1.3.1 举办 Chem-E-Car 竞赛的主要目的

（1）为化学工程专业的学生提供机会，采用团队协作的方式，手工设计和组装一辆化学动力驱动的模型小车。

（2）锻炼学生安全地控制化学反应的能力。

（3）设计和制造一辆以化学能源为动力的小车，小车能负载一定重量的水行驶规定的距离并停下。

（4）鼓励学生积极参与行业组织。

（5）提高公众、行业领导者、教育工作者和其他学生对化学工程原理的认识。

Chem-E-Car 竞赛分为两个赛程。第一个赛程是在区域会议上举行的地区赛，第二个赛程是在 AIChE 学生年会上举行的年度决赛。地区赛和年度决赛是单独的竞赛。通过地区赛的安全审查并不能保证您的队伍将通过年度学生会议 Chem-E- Car 竞赛的安全审查。

所有 Chem-E-Car 参赛队必须来自已经向 AIChE 提交学生分会年度报告的学生分会。可以访问 www.aiche.org/studentchapterannualreport 来提交报告。

Chem-E-Car 竞赛由海报竞赛，安全审查和性能竞赛组成，详见后续章节。

在竞赛期间，所有参赛队都需要向观众介绍其作品，简要阐述驱动和停止机制。参赛队还将有机会在年度学生会议竞赛中提交展示其队伍的视频。

1.3.2 地区赛概述

1.3.2.1 基本概述

- 每所大学只允许选拔一支队伍参加全国比赛。
- 下述的官方规则同时适用于地区赛和年度决赛。
- 由 AIChE 指定的安全和规则协调员将参加每个区域竞赛。该协调员是该区域竞赛的竞赛规则问题、安全问题、违规、取消资格等的最终解释者。
- 协调员所做的裁定仅适用于地区赛，年度决赛的裁定不以地区赛的结果为依据。

1.3.2.2 年度决赛

无论在区域竞赛中有多少支队伍通过资格审查程序，每个学校只有一支参赛队伍可参加年度学生会议竞赛。

（以下注意事项仅适用于 2026 年美国年度决赛）

- 如果您的队伍参加了区域竞赛但未获得年度学生会议竞赛资格，您可以发送电子邮件至 studentchapters@aiche.org 并要求加入候补名单。
- 对于 2026 年度学生会议竞赛，每个竞赛队伍将收取 200 美元的参赛费。此参赛费将被用于对竞赛现场的化学品和废弃物的处理。

1.3.2.3 年度决赛奖项（仅适用于美国年度决赛）

年度决赛的相关奖项是：

- 第一名：2000 美元奖金和奖杯
- 第二名：1000 美元奖金和奖杯
- 第三名：500 美元奖金和奖杯
- 第四和第五名：奖杯
- 最佳使用生物反应为小车提供动力奖：500 美元
- SAChE 安全奖：颁发给最佳应用化工过程安全原理的队伍——奖杯
- 竞赛精神奖：授予由评审小组决定的最具团队精神的队伍
- 最佳创意设计奖：奖杯
- 金轮胎奖：授予由所有参赛队投票选出的最具创意的驱动系统的队伍
- 最佳视频奖：奖杯
- Chem-E-Car 竞赛海报奖：海报竞赛第 1 名至第 5 名获得奖杯
- 杰出体育精神奖：奖杯
- 最佳队名奖：奖杯
- 2026 年 Chem-E-Car MathWorks 建模与仿真奖：颁发给在使用 MathWorks 工具进行 Chem-E-Car 设计和仿真方面表现出色的团队——奖杯（MathWorks 赞助）

1.3.3 Chem-E-Car 竞赛海报展示和安全审查规则

1.3.3.1 海报展示概述

在竞赛当天海报必须与小车一起展示。这张海报应该清楚地描述：

- 小车如何通过化学反应提供动力
- 如何通过化学反应控制小车停止
- 小车的独特之处
- 设计中的环境和安全特点
- 小车设计说明、设计图和试验结果

1.3.3.2 队伍成员：

海报竞赛和评审将在 Chem-E-Car 性能竞赛之前进行。在评判期间，队伍成员必须在场，以回答评委的提问。

1.3.3.3 最低分数：

团队必须在海报竞赛中获得及格分数，才能晋级到 Chem-E-Car 性能竞赛。海报将根据以下标准进行评判：

（1）海报和队伍成员展示的质量（50%)

（2）设计小车的创造性和独特功能以及安全考虑因素（35%)

（3）表明所有队伍成员了解反应及校准方法，并且展示出队伍成员回答评委提出的问题的能力（15%)

1.3.3.4 获奖者：

海报竞赛的获奖者将在性能竞赛结束时公布。

1.3.3.5 安全检查：

（1）在海报竞赛期间，审查小组将检查每辆小车，以确保满足所有安全要求，并确保小车将在对参赛队员、工作人员和观众没有风险的情况下进行操作。

（2）如果审查小组认为小车可以安全运行，那么小车将获准参与竞赛。

（3）此许可不是自动获得的，必须遵守下面列出的准则/程序。如果参赛小车被认为是不安全的，那么它将无法获得参赛许可。

（4)无论在之前的地区赛中参赛小车是否获得参赛许可，现场的 Chem-E-Car 竞赛安全审查员拥有参赛许可的最终决定权。

1.3.4 Chem-E-Car 性能竞赛规则

1.3.4.1 距离

（1）每辆小车将有两次机会行驶指定的距离。两次比赛机会中规定距离相同。

（2）赛事组委会将在性能竞赛开始前一小时告知每支队伍行驶距离。距离范围为 15 至 30 米±0.005 米。

（3）一旦海报竞赛结束，团队不得对其车辆进行重大更改，除非他们已做好准备，并获得批准的变更管理（MOC）。参赛队只允许调整化学反应中的“燃料”或反应物的用量。

1.3.4.2 路线布局和距离测量

（1）竞赛赛场区域为宽 5 米，长 15-30 米的矩形。

（2）小车将从其前端开始接触指定的起跑线，目的是使小车保持在指定终点线的边界内。竞赛成绩取决于从小车最前点到终点线的距离，无论小车是否在终点线之前或之后停止。

（3）超出边界的小车将通过其离开边界的位置到终点线的距离来测量其距离，并且将增加 3 米的罚分。

（4）“超出边界”被定义为车的任何部位超出或接触到边界。如果使用胶带标识边界，则胶带内侧为边界位置；如果墙体为边界，则与墙接触为超出边界。

（5）如果小车在起跑线处开始倒车，则跑车距离将被计为 0 米。

（6）场地也可能设置安全线。触碰安全线的小车将被取消该次尝试的成绩。

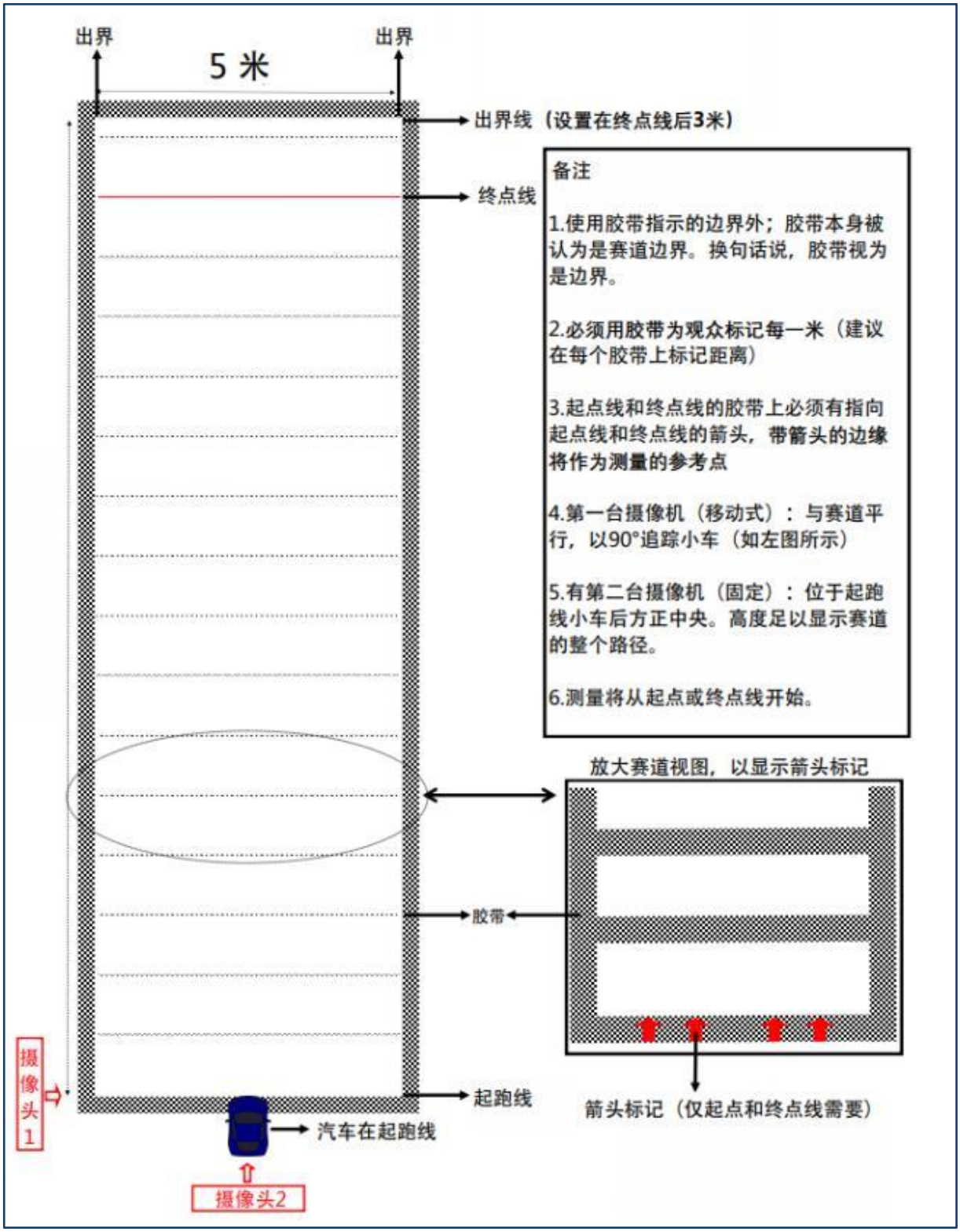

图1　性能竞赛区域示意图

1.3.4.3 竞赛流程

（1）Chem-E-Car 裁判（MC）将在开始起跑之前通知每个队伍。

（2）每辆车将有两次机会完成竞赛。每次小车需在两分钟的时间内启动和完全停止。任何在两分钟内没有停止的小车将被取消该次的成绩。

（3）队伍的最终成绩取两次跑车的最佳成绩。

（4）如果一支队伍没有出现在起跑线上，或者小车未能启动，则将宣布竞赛顺序中的下一支队伍并要求其立即前往起跑线。

（5）竞赛顺序在第一轮和第二轮之间不会改变。两轮竞赛之间将有 15 分钟的休息时间。

1.3.4.4 起始线程序

（1）小车从启动到停止，必须在 2 分钟内完成。

（2）每支队伍应有 1 名队员从起跑线处跟随小车一同前往终点线。在测量距离后，队伍成员负责取回他们的小车。

（3）一旦小车被放置在起跑线上并且 2 分钟的计时开始，所有车轮必须保持接触地面。推动、抬起小车或小车的一部分将导致该次尝试被取消资格。

1.3.4.5 竞赛组织工作

（1）比赛距离和出场顺序将在比赛开始前一小时公布。

（2）如果竞赛顺序在你们队伍之前的小车被取消资格，那么你们将在原始顺序中向上移动一个位置。

（3）竞赛开始前五分钟，召集每条赛道的前三支队伍，准备开始竞赛。每条赛道的第一支队伍将在起跑线上，第二支队伍在性能竞赛区域准备好的桌子上（等候区），第三支队伍准备开始转向等候区。

（4）竞赛开始前一分钟，第一支队伍将会收到准备开始竞赛的提醒。

（5）被叫到起跑线后，每个队伍有两分钟时间启动小车。

（6）小车有两分钟时间行驶并停止。

（7）如果小车超出边界，计时也将停止。

（8）如果小车在两分钟内没有停止，那么小车所属队伍将被取消该次的成绩。

（9）小车停止后，测量其距终点线的距离。一旦完成测距，令下一支队伍从等候区前往起跑线处。

（10）余下比赛进程重复 1.3.4.5-1.3.4.9。

1.3.4.6 小车驱动系统

（1）本次竞赛的目的之一是让学生展示控制化学物质（反应物、催化剂或者其他与化学反应控制有直接关系的物质）的能力。

（2）化学反应是推进小车的唯一动力源。

（3）小车的行驶距离必须是通过化学反应来控制，控制过程必须通过定量改变和直接控制化学物质的浓度来实现。

（4）该化学反应物质必须是固体，液体或气体。

1.3.4.7 小车设计

（1）参加竞赛的小车，特别是小车的驱动系统以及启动和停止机构，必须具有重要且可证明的学生设计部件。

（2）推进小车的化学反应和启动/停止反应（如果有的话）必须在竞赛期间物理地固定在小车上（即不允许预加载诸如电容器组件的驱动系统）。

（3）小车必须由化学反应提供动力，并且必须通过对化学物质浓度的可量化变化和直接控制来停止。

（4）这种化学反应物必须是固体、液体或气体。

（5）自动驾驶车辆：车辆必须是自动驾驶的，不能远程控制。不允许通过推动来启动车辆。任何与化学反应无关的车辆启动时的向前移动将导致取消资格。禁止在起跑线或起跑线前“拖延”时间。不允许在起跑线处抬起车辆以使车轮开始转动。

（6）允许使用车载计算机控制系统（如 Arduino 或 Raspberry Pi 单元），但不得以任何方式控制/测量行驶距离。程序必须在比赛前加载到控制器/计算机/处理器上，且比赛开始后（即距离公布时）不得更改设置。

（7）比赛开始后及比赛期间，禁止与车载计算机/控制器进行有线或无线通信。

（8）比赛当天，队伍可能会被要求向规则委员会提供其完整程序的副本。

（9）编码器：队伍也不得使用编码器来调节车辆速度以控制行驶距离。

（10）稳压器：队伍不得使用稳压器来调节推进系统反应与小车电机的电压/电流。MOSFET（金属-氧化物半导体场效应晶体管）、H 桥电机驱动器、MOSFET 触发器、晶体管、齐纳二极管（Zener diodes）、电压或电流限制器、快速切换继电器（仅用作简单通断开关、无频繁通断的继电器是允许的）、电容器等类似元件均不被允许。任何用于从电池向电机提升、降低或平滑输出功率（包括电压和

/或电流）的元件，在本规则中均被视为“稳压器”。

这项修改是有意为之，并非要移除电池，而是为了激发创造力。比赛最初由 Fogler 博士构思时，其核心目标是通过化学原理来控制车辆行驶的距离，而非依赖电子设备、Arduino 开发板或微处理器。

可以通过测量电压和/或电流并为保护设备免受过电冲击而完全切断电源。但电源一旦切断，便不得再次接通。

（11）无机械制动：不得对车轮、齿轮、驱动轴等或地面施加机械力以减速或停止车辆（例如，不允许使用刹车）。

（12）机械或电子计时装置：不得使用机械或电子计时装置来停止化学反应或停止车辆。此外，计时装置不能利用通常被认为是瞬时反应的机制。例如，使用瞬时反应（如酸碱反应或沉淀反应）的恒定或排液进料传感装置是不允许的。另一个例子是从容器中排出的液体作为停止开关。这将被视为机械计时装置，也是不允许的。

（13）内燃机：允许使用替代燃料（如生物柴油、乙醇等）的内燃机。燃料必须完全由学生合成（不允许添加剂混合）。队伍必须展示明确的安全程序以维护和操作该发动机，并考虑室内操作。内燃机不得向比赛空间排放可见的燃烧烟雾，并需遵守声音限制。详见安全规则以获取更详细的讨论。

（14）热电装置（动力系统）：从制造商购买的热电堆必须至少有一侧（热侧或冷侧）由化学反应控制。注意：相变（包括熔化和结晶）、混合和溶解不被视为化学反应。

（15）燃料电池：任何从供应商处购买的车辆，如果未对其操作进行重大修改，将被取消资格。例如，队伍不能购买燃料电池车辆并在未进行任何修改的情况下参赛。任何购买商业燃料电池或自行建造燃料电池的队伍必须合成所使用的燃料；例如，如果队伍购买了商业甲醇燃料电池，则必须合成甲醇并提供其合成过程的验证。燃料电池使用的氢气必须通过现场或车辆上的化学反应生成，而不能来自商业设备或预加载的罐体。必须采取适当的过程安全措施。在燃料合成过程中必须遵循适当的过程安全措施。合成程序必须在工程设计文件（EDP）中明确定义。

禁止使用带内部稳压器的燃料电池（参阅第 1.3.4.7.（10）条规则）。

（16）商业电池：不允许使用任何类型的商业电池（例如 AA 电池）作为动

力源。商业电池可用于专用仪器（如探测器、传感器、阀门、混合浆、泵）。

1.3.4.8 小车的大小

（1）小车的所有部件必须能够装入尺寸不大于 40 厘米×30 厘米×20 厘米的箱子中。可以拆卸小车以满足此要求。

（2）如果裁判不确定在拆卸时小车能否装进箱子内，他们可能会要求队伍来证明他们可以做到这一点。

1.3.4.9 小车资金成本

（1）所有小车部件和化学品的成本不得超过 3500 美元。小车成本包括任何设备的捐赠成本。

（2）大学的机械车间和其他人员的捐赠不包括在小车总价中。预计每所大学都可以平等地获得这些资源。

（3）压力测试的成本也不包括在小车的成本中。

（4）必须给出用于估算设备捐赠成本的方法。预计标准财务程序将用于估算此费用。

（5）团队必须在其 EDP 内包含小车的资金成本明细。

1.3.4.10 小车设计相较于往年的变更要求

（1）如果团队参加了 AICHE 年度学生大会 Chem-E-Car 竞赛（例如 2025 年赛事），则在下一年（即 2026 年）必须对推进系统和停止装置进行重大修改。

（2）必须对推进系统和停止机制的化学反应进行实质性改变，并在 EDP 的 JSA 表格中注明。离子反应方程式未改变不被认为是化学反应的实质性改变。例如，在小苏打与酸的反应中，改变酸的种类不被认为是“实质性的变化”。

（3）鼓励必要时对赛车地盘或反应室进行结构改进，但如果不改变推进系统和停止机制的化学反应，则不被认为是足够显著的变化。

1.3.4.11 队伍成员身份和行为

（1）出席会议的所有队伍成员必须是活跃的 AIChE 成员，必须完成对应赛事举办地的学生区域会议或年度会议的注册。

（2）教师和研究生只能为学生解决疑问。教师不能为该项目提供想法。

（3）在请求小车安全协助方面没有限制。队伍可以向其教师顾问，其他教师，其他大学以及工业和其他地方的专业从业人员寻求安全协助。

（4）规则和安全审查员在安全审查和海报竞赛上提出的所有问题必须由本科学生队伍成员回答。本科生需要具备解释小车设计，操作，安全和规则合规性的能力。

（5）参与该项目的学生必须签署一份声明，表明他们已阅读、理解并遵守这些规则。该声明必须包含在 EDP 中。

（6）在性能竞赛期间，只有五名队员可以同时进入操作区。队伍成员可以在竞赛期间进行更换。

（7）所有队伍成员和指导老师必须完成所需的安全培训课程，可在 www.aiche.org/chemecar 上找到。所有参赛学生必须每年重修该课程。

（8）参加 Chem-E-Car 竞赛的所有学生分会团队必须向 AIChE 提交学生分会年度报告。（注：2026 年 1 月 1 日后新成立的 AIChE 学生分会可免于此要求。）

1.3.4.12 获奖队伍和奖项

（1）获胜的队伍是最接近竞赛距离的队伍。即小车最前部与终点线之间的距离的绝对值，无论小车是否在终点线之前或之后停止。

（2）如果产生平局，两次尝试中小车距离平均值最接近竞赛距离的队伍可能会被宣布为获胜者。

（3）Chem-E-Car 性能竞赛的获奖者将在性能竞赛后立即宣布。

1.3.4.13 现场安全裁判和规则协调员

如果在安全问题或其他判断标准方面存在任何疑问，请联系 Chem-E-Car 委员会。现场的规则和安全审查员具有最终解释权。

二、2026 中国大学生 Chem-E-Car 安全规则

2.1 2026 年中国大学生 Chem-E-Car 安全规则的变化

以下变化参考 AIChE Chem-E-Car 官方规则进行修改

（1）乙酸最高允许浓度从 60%降至 50%。（2.3.19）

（2）将最大允许工作压力（MAWP）与指定温度下系统最薄弱部件绑定（2.3.21），并将最大操作压力（MOP）限制为在任何温度下的 200psig。

（3）第 2.3.27 条明确限制：压力工况下禁止使用塑料制品

（4）明确禁止在压力工况下使用聚氯乙烯硬管（硬质 PVC 管）（2.3.27）

（5）美方 Chem-E-Car 委员会将提前通知：在 2027 年规则中，铅基电池将不再被允许使用（2.3.17 禁用化学品）；2027 年中国地区赛也将禁止使用。

2.2 Chem-E-Car 安全规则概述

AIChE 的 Chem-E-Car 竞赛安全规则的目的是确保在竞赛各个阶段（包括制造、测试和竞赛环节）准备与操作的安全。我们将根据您的队伍提供的文档对您的系统设计和安全合规性进行审核。

您的小车安全审核将分两个阶段进行：

（1）在线审核

队伍将以电子方式提交完整填写的工程文档包（EDP）并且会收到反馈。AIChE 工作人员将向所有队伍传达 EDP 修改意见。若超过了规定的截止日期仍未提交完整的 EDP 文件，将导致队伍的竞赛资格被取消。EDP 模板可从 Chem-E-Car 竞赛规则网站 www.aiche.org/chemecar 下载。（中国地区赛将由组委会负责 EDP 的审核工作）

（2）现场审核

在竞赛当日进行现场审核，队伍必须用文件夹或活页夹携带打印好的 EDP、EDP 补充文件、EDP 反馈文件和 MOC 表格，并准备好回答现场安全审查员提出的问题。队伍若未能通过竞赛的这一阶段将导致其被取消竞赛资格。

2.3 竞赛安全规则

2.3.1 安全审核：在线

2.3.1.1 EDP

您必须在截止日期前完整填写并提交 Chem-E-Car 的工程文档包（EDP）。请使用 AICHE 官网提供的 EDP 模版，并按照“大学名称-EDP.pdf”的格式重命名 EDP 文件，例如：“天津大学-EDP.pdf”。完整的 EDP 包括以下内容，顺序如下：

（1）工作安全分析

包括您的小车及其工作原理的描述。

（2）照片

建造完成后的小车图片。这些图片必须是最新的。整辆车必须在图片中可见。如有必要，移除小车顶部以露出电气控制装置。需要从不同角度拍摄小车。不接受图纸或 AutoCAD 文档。

（3）安全培训和规则认证页

此页面必须由所有队伍成员和指导老师签署。裁判将使用此页面确定：

- 启动和停止机制是否符合规则
- 每个人是否都已完成所需的安全培训
- 已明确主要危险并已正确控制它们。

认证页必须在竞赛前签字。请注意，队伍成员在认证页上签字之前，其对小车的操作时间必须至少有 10 小时。注意：建造小车的时间不能算作操作时间。

（4）危害分析

完成所有页面，包括附上制作小车的实验室平面图或图表。

（5）化学信息

包括所涉化学品的描述，以及要发送给竞赛主办方的化学品清单。

（6）化学危害和处置

本部分要求参赛队伍对所处理的化学品进行相关的化学研究。列出能在 SDS 上找到的每种化学品的属性。如果化学品不易燃，请写 N/A。

（7）标准/安全操作流程页面

提供小车安全启动、运行、关闭和清理的分步详细信息。此页面应足够详细，以便不熟悉小车的人也能够安全地配制溶液并操作小车。此部分要求写出您的队伍进行化学实验的具体步骤。请访问 NIOSH 网站搜索并查找此类信息。如果不适用，请用 N/A 表示。

（8）设备表

以表格形式完整地列出小车上每件设备的完整清单，包括每件设备的制造商。

包括每件设备的操作限制（最高温度和压力），并确保相关的材料兼容性。当制造规格表缺失时，学生应根据材料的属性来确定这些操作限制。需要附上 CAD 图或其他示意图，标明每件设备在小车设计中的位置。在示意图和清单中，应当使用同一套命名方案。若小车含电子电路，需附上一份根据设备清单标明各组件的电路图。

（9）压力

对于压力大于 5psig（0.345barg）的小车：请完成并将以下内容添加到您的 EDP 文档中：压力释放负载的定量设计基础；压力释放装置的尺寸计算；压力释放的测试方法和结果。有关压力测试所需内容的完整说明，请参阅“安全规则”的附录 A.

（10）氢气排放计算（包括任何易燃成分）

如果使用氢气并计划少量排放，则必须提供计算结果，证明排放气流浓度在与环境空气混合后低于 1/4 LFL 值。说明对环境空气流速所做的任何假设。例如，若 LFL 为 10%，则安全排放浓度应小于 2.5%。

（11）小车变更管理

在线 EDP 审核完成后，必须按照 EDP 评审员提出的建议完成所有变更，并按照您所制备的流程记录这些更改。至少需要包含一份由 AICHE 提供的变更管理表（MOC）。该 MOC 表格必须在现场安全检查期间出示。

（12）小车资金成本计算

参照竞赛中关于小车资金成本的规则，在此处展示小车的资金成本以及所有相关计算过程。

（13）团队废物标签

需要使用 EDP 模版中的表格，完整填写用来描述比赛当天每一类废物流的标签。这些标签必须完成并纳入 EDP 文档。必须打印并携带足够份数的标签以覆盖比赛中可能产生的所有废物。在任何队伍被允许将废物投放至 AICHE 废物收集系统前，必须提交完全填好的废物标签。

注意：所有固体废物必须拆解、无害化处理且完全去除液体残留。

2.3.1.2 EDP 增补文件

请将以下信息合并到另一个单独的 PDF 中，并标题为“大学名称-EDP-Supplement.pdf”。例如“天津大学-EDP-Supplement.pdf.”。这将帮助 EDP 评审员在 AICHE 网站上轻松定位两个文件。若需提交修订版请按照以下命名方

式：“天津大学-EDP-Supplement-V2.pdf.”

注意：EDP 增补文件的首页必须包含目录，并在下方列出各个标题。请为每个 SDS 和设备制造商信息创建子编号，便于参赛人员和评审员查找各项内容。

（1）安全数据表（SDS），所有反应中使用或产生的化学品需提供 2012 年后制定或修订的 SDS。

（2）制造商的规范文档或定制组件的规范参数。对于任何商业或定制组件，学生必须列出材料和兼容性。

（3）安全培训课程的证书需要包括团队的全部成员及指导教师。

（4）您需要保存的有关 EDP 的任何其他信息，这些信息不包含在原始 EDP 文档中。

2.3.2 安全审核：

（1）现场

在竞赛当天，审查小组将检查每辆车，以确保满足所有安全要求，并且确保小车将在对操作员，竞赛工作人员和观众没有危险的情况下操作。无论小车是否被允许在以前的区域竞赛中操作，竞赛现场的安全审查员都有最终决定权。

（2）比赛许可

如果审查小组认为小车可以安全操作，那么小车将获准参与竞赛。如果小车被认为是不安全的，那么它将不会获得竞赛许可，无法参加性能竞赛。

2.3.3 禁止化学品处理/违规化学品运输和储存

（1）运输化学品

参赛队伍不允许通过小车将危险化学品运输到竞赛现场。私人、大学或租赁车辆不得在竞赛现场运输任何化学品，即使是在短距离内也是如此。

对于普通的家用化学品，如小苏打、醋等，在其市售浓度下，不受此规定的约束。该化学品要符合普通家用化学品的条件，必须可在杂货店等零售点购买和提取。参赛队伍承担安全运输这些家用化学品的全部责任。

（2）化学品运输

Chem-E-Car 队伍应与他们所在大学的 EHS(环境健康与安全，或类似名称)部门合作，确保所有物品的运输都符合 DOT 危险品运输法的规定。确保一切化学品都贴有正确的标签。

运往比赛场地的所有危险化学品和受管制化学品必须使用原包装，供应商的所有标签必须完好清晰。

比赛结束后，任何化学品不得运回参赛队伍或其所在大学。

（3）违规化学品储存

化学品不得存放在酒店房间或其他不符合化学品储存条件的设施中。小苏打和盐等普通家用物品除外。

（4）学生自制电池

任何学生或参赛队伍不得运输或装运电池外壳内含有危险材料的学生自制电池（即含酸的预制铅酸电池）。否则将直接违反规则 2.2.3（1）“运输化学品”的规定。

学生可以运输电池组件，前提是这些电池组件必须是非危险品，并且已经过清洁、中和处理，确保不受任何先前使用的影响而保证安全。

2.3.4 不得使用压缩氢气瓶

（1）氢生成

小车上使用的所有氢气（例如燃料电池）必须在现场或小车上生成，保持压力低于 5 psig（0.345 barg）。必须证明有适当的安全预防措施和安全操作。参阅安全规则 10，注意含氢气系统必须排出空气/氧气。在竞赛当天给出化学品之前，不能制造氢气。

（2）商用储氢罐

不允许从压缩氢气瓶或商用储氢罐（例如水溶液或固体氢气筒）中填充容器。

2.3.5 违规的小车调试

小车的测试只能在具有化学处理能力的实验室或其他设施中进行。不允许在酒店或宿舍走廊，仓库或其他非化学处理设施进行测试。酒店或宿舍走廊不允许混合化学品，包括普通家用化学品。

2.3.6 化学品的处置

废弃物的处理对竞赛而言既是重大风险，也是重大成本。参赛队伍应了解其产生的所有废物流。运往竞赛场地的所有化学品和从竞赛场地产生的废物必须以安全和环保的方式处理，并遵守当地和国家的监管措施。请尽量减少运送到竞赛现场的化学品，以降低处置成本。

（1）现场处置

参赛队伍有责任将每种废物流安全地丢弃到以下可用废物流中：酸、碱、有机、水、固体废物。所有参赛队伍组装的物品在固体废物中处理时，必须以中性 pH 值 （pH 6-8） 分离成单独的组件，并装入各自的防水容器中，同时在容器

上牢固地贴上参赛队伍废物标签。

（2）参赛队伍废物标签

参赛队伍废物标签必须根据预期废物流在竞赛之前完成，并包含在参赛队 EDP 的最后。参赛队伍废物标签必须与所有排入 AIChE 废物容器的废物一并提交，并至少包括以下内容：废物描述、浓度、体积、参赛队伍名称、表格编号。

（3）非法处置

不遵守化学品处理规则可能会导致安全事故，并可能被暂停参加今后的比赛。

2.3.7 明火、烟、噪音

所有小车不允许出现任何明火或冒烟。小车内部不得有火焰。任何在准备区或赛道上产生明火或冒烟的参赛队伍将被取消比赛资格。

（1）内燃机（ICE）

该规则的唯一例外是允许使用学生合成的替代燃料的商用内燃机（ICE）存在内部火焰。在实验期间，带有 ICE 的小车不允许产生烟雾。参赛队伍必须说明该发动机的维护和操作的简洁安全操作步骤。此外，带有 ICE 的小车必须展示一个可证明且重要的学生设计的组件。

（2）噪音

内燃机的噪音不得超过 90 分贝（从 1 米的距离测量）。

（3）气体排放

当排气已经被催化转换器或其他过滤介质适当过滤以除去含有烟灰，令人讨厌的气味和烟雾的危险废气物质时，允许从 ICE 中排出气体。

（4）反应产生的气体排放

任何 NFPA 健康等级为 3 或 4 的副产品在排放前都必须进行洗涤或清除。

2.3.8 激光

激光器将一束聚焦的能量射向目标区域，根据类型和功率的不同，可能会造成严重的人身伤害和火灾隐患，小车设计中使用的任何激光都需要仔细设计，并在设计的危险分析中加以考虑。

不允许使用 IEC 3B 型和 4 型激光器。小车所使用的任何激光，无论颜色如何，其最大输出功率均不得超过 5 毫瓦。

2.3.9 焊料

在小车的制造或装配过程中，不得使用含铅的焊料。竞赛中不能进行有计划的焊接。焊接应仅用于维修目的，并且应尽量减少使用。在参赛之前，所有需要

的焊接工作都应在您的所在机构内进行，并且要确保有良好的通风条件（最好是在通风橱内）。

2.3.10 液体/蒸气/气味排放

不允许排放液体，包括水。不允许令人厌恶的气味排放。所有反应的液体产物应适当地收集并包含在容器内，且妥善处理（例如，使用洗涤器/储罐）。只有在紧急救援情况下才能进行排放，以保护设备免受破裂和/或爆炸。

（1）氢气排放

“无气体排放”规则的一个例外是允许少量的氢气排放。如《安全规则》2.3.1.1（10）所述，学生应在 EDP 中提供计算结果，以向审查员证明任何排出的氢气已稀释至低于 LFL 的 25%。

（2）释放加压气体

虽然需要使用减压装置作为保护手段，但不允许在竞赛期间释放加压气体（大于 5 psig [0.345 barg]）。如果减压装置在竞赛期间因任何原因而起作用，则该队伍将被取消此次成绩。

（3）气体排放

对于含有 NFPA 健康等级为 0、1 或 2 的气体，允许未加压的、未经处理的气体作为反应副产物排放。（例如：水蒸汽、CO_2 均可以，H_2S 和 SO_2 则不可以）。如果小车排出的气体被认为是不合适的，现场安全审查员可能会取消其参赛资格。由于产生过量气体而导致的资格取消将由安全委员会自行决定，并且该裁决是最终的，不能受到质疑。

2.3.11 具有反应活性的物质

使用任何可能与空气/氧气发生反应的化学品（例如易燃气体）的参赛队伍，在将反应气体引入系统之前，必须用适当的惰性气体对系统进行吹扫。用于吹扫系统的惰性气体体积必须至少是系统体积的三倍。吹扫可以通过使用小型惰性气体罐来完成

2.3.12 敞口或不安全的容器

小车上含有化学物质（包括水）的所有容器必须牢固地连接到小车上，以防止容器在竞赛期间翻倒。该容器的盖子也必须牢固地连接到容器上，并且在竞赛的任何阶段其必须能够防止化学品逸出，任何阶段也包括翻车事故。

2.3.13 起跑线上不得打开容器、移动液体或倾倒化学品

起跑线上不允许打开容器、加入化学品或倾倒化学品。这些内置的化学储液槽必须在团队的准备台上装填，然后才能移动到准备比赛的桌子和起跑线。在起始线处可以使用手动或自动的阀门或开关。违规操作将导致该轮跑车资格被取消，基于所包含的化学品，内置化学品储槽须符合密封要求，包括 MOC 兼容性，双重密封，盖子等。小车上的所有容器必须有安全的盖子，妥善安装以防止溢出。

（1）所有化学品必须放在小车上，并在小车上安全固定后才能搬运至起跑线上。从起跑线处不得带走任何物品，也不得将任何物品留在准备区。如果在起跑线上或比赛中有任何部件（包括从小车上掉落的）将导致该轮比赛的资格被取消。所有容器必须贴上适当的标签并被容纳。

（2）禁止使用注射器：任何容量的注射器（以及延长针）都不允许在小车设计中使用。这一规则的改变也是为了促进更好、更安全的设计。在准备台上可以使用贴有标签的注射器或移液器，但禁止使用锋利的针头。

2.3.14 禁止使用尖针

不得在任何容器中使用尖针（包括但不限于车辆的操作和准备）。

2.3.15 禁止绑扎气球

禁止在竞赛场地内使用预先系好的气球。这主要与将含有比空气轻的气体的气球带入比赛场地进行反应或净化有关。大多数 ASC 场馆都禁止将聚酯薄膜气球悬挂在天花板上，因为过去曾发生过这种气球触发火警的事件。

2.3.16 无受管制化学品

由于可能涉及的危险，参加竞赛的任何小车都不允许有 OSHA 监管的致癌化学品。OSHA 列出了许多具有特殊危害的化学品。这些化学品的处理超出了竞赛期间可用的管理系统的范围。有关详细信息，请访 www.osha.gov。受管制的化学品包括但不限于：

1,2-二溴-3-氯丙烷	β-萘胺
1,3-丁二烯	β-丙内酯
2-乙酰氨基芴	双氯甲醚
3,3'-二氯联苯胺	煤焦油沥青挥发物
4,4'-亚甲基二苯胺	环氧乙烷

4-氨基联苯	乙烯亚胺
4-二甲氨基偶氮苯	甲醛
4-硝基联苯	无机砷
丙烯腈	甲基氯甲醚
α-萘胺	二氯甲烷
石棉	N-亚硝基二甲胺
苯	氯乙烯
联苯胺	六价铬
甲基二苯胺	所有含镉的化合物
粉状硅胶	所有含铍的化合物

2.3.17 无高反应性/不稳定的化学品

不允许使用高活性或不稳定的化学品、原材料、中间体或产品。这包括下列GHS危险分类中的任何一种化学品:爆炸物、易燃液体（第1类）、易燃固体（第1类）、自反应化学物质（A类或B类）、易燃固体、易燃液体、自加热物质、与水接触会释放可燃气体的物质、氧化液体（第1类）、氧化固体（第1类）、有机过氧化物（A类或B类）、急性毒性（第1类）和致癌性（第1类）。这也包括美国环保署公布的极端危险物质清单上的任何化学品。特别是下面这些化学物质。禁用化学品清单包括（不详尽）：

0-二硝基苯	异丙苯过氧化氢
3-溴丙炔	过氧化二乙基
过氧化乙酰	过二碳酸二异丙酯
二叔丁基过氧化物	硝基甲烷
二乙烯基乙炔	过氧乙酸
亚硝酸乙酯	氨
硝酸甘油	

2.3.18 不能使用浓度大于30%液体过氧化氢

液态过氧化氢非常不稳定，并且在浓度大于 30%时难以处理。

2.3.19 酸浓度限制

酸的浓度越高，风险越大。常用酸的最大允许浓度如下。对于未列出的酸性物质，请使用 Chem-E-Car 问题表检查您建议的酸性物质浓度是否允许。一般来说，如果需要使用通风橱来分配酸液，则不允许使用。

酸	最高浓度
醋酸	10M（50% vol）
盐酸	3M（10% vol）
硫酸	5M（30% vol）
硝酸	禁止

2.3.20 碳化合物限制

不允许使用粉末状干燥的主要含碳化合物，例如炭黑、石墨或活性炭。您可以在自己的大学制作预湿碳化合物，并按照比赛的运输说明和规则进行运输。

2.3.21 压力限制

由于压力中包含大量能量，加压容器和小车部件存在显著的爆炸危险。学生队伍还必须证明已安装了适当的安全系统以防止爆炸。

（1）最大允许工作压力（MAWP）

应该是在特定温度下，加压系统中最薄弱部件可以承受的最高压力。~~不允许~~请注意，“小车系统”的 MAWP 可能小于制造商为压力容器列出的 MAWP。例如，压力容器的制造商可能会将最大允许工作压力（MAWP）标为 100 psig，25 ºC。但如果该容器与一个管道系统相连，而该系统中最薄弱的部件在 25 ºC 时的最大允许工作压力仅为 50 psig，那么整个系统的最大允许工作压力就是 50 psig， 25 ºC（即受到最薄弱部件的限制）。

（2）最大工作压力（MOP）

不得超过反应容器 MAWP 的 90 %，并且应为系统中最弱压力额定组件的工作压力的 90 %。任何温度下，小车的最高压力（MOP）不得超过 200 psig（13.8 barg）（也就是说，小车上的压力系统在任何情况下都不允许超过 200 psig 的压力值运行）。出于初始设计目的，可以从化学计量估算最大操作压力（MOP）；但是，必须在小车运行后测量实际压力。学生队伍必须通过适当的压力测量方法证

明正常操作期间的压力不超过设备规格。

2.3.22 压力表

压力大于 5 psig 的所有容器和设备必须具有压力表，其压力范围为 0 psig 至 MOP 的 2 倍。

2.3.23 紧急泄压设备

所有压力大于 5 psig (0.345 barg)的小车必须将行业标准安全阀设定为不超过小车 MOP 的 1.1 倍。

（1）泄压设备测试

必须对该阀门进行测试，并且必须在安全文档中提供证明。如果使用固定设定点 PRV，则制造商规格必须包含在 EDP 文档中。如果使用可调设定点 PRV，则必须在 EDP 中包含相关证明，证明 PRV 已经在该设定点测试过，并且需要有一位指导教师的签名。

（2）尺寸计算

所有紧急泄压设备的尺寸必须合适。紧急泄压系统计算必须包含在 EDP 文件中，并且必须由您的指导老师审查和批准。此外，必须在 EDP 中明确说明紧急泄压装置的以下设计规范：

- 假设反应物的总量
- 反应物浓度
- 初始温度

（3）正确定位紧急泄压设备

泄压装置必须放在正确的位置。对于反应容器来说，泄压阀必须位于容器顶部，在容器和泄压阀之间不应有任何阀门。还必须考虑可能妨碍释放功能的从容器中夹带的液体或固体。如果减压阀（压力调节器）将下游压力降低到高于大气压力的值，则减压阀或调节器下游的所有管道和设备必须能够承受该压力等级或由适当的泄压阀或安全隔膜保护。

（4）管道

连接泄压装置和容器的管道必须具有适当的尺寸，并且必须尽可能短，以防止在泄压条件下的压力下降。

压力限制示例

小车系统具有以下组件：

反应釜　　MAWP = 1800 psig（25 °C）

钢管　　MAWP = 150 psig（25 °C）

小车系统　MAWP = 150 psig（系统中耐压最低的组件）

MOP = 135 psig（150 psig × 90 %)

PRV 最大设定值为 149（1.1 × 135 psig） 合适的压力表范围为 0 - 270 psig（2×MOP）

2.3.24 压力测试

所有组件，包括容器，管道和配件，阀门，仪表，过滤器，必须经过认证，可以在高于小车最大工作压力（MOP）的压力下运行。对于大多数组件，压力规格可以直接从制造商处获得。此信息必须呈现在工程文档包中。对于设备，可能没有压力认证。在这种情况下，您需要让某人为您测试设备，或者在指导教师的监督下自己完成压力测试。参见压力容器测试协议和程序的附录 A。

2.3.25 适当的控制系统，以防止过压或误充压力系统

学生队伍还必须意识到容器内的压力取决于所加入的反应物的量。学生必须证明有适当的管理系统和控制措施，以确保向小车加入适量的反应物。

2.3.26 标准操作流程（SOP）

必须在小车的标准操作流程中包含以下步骤，以确保正确操作：

（1）所加入的数量应由所有队伍成员商定，并且必须得到数据的支持，此数据从操作小车的过程中获得。

（2）至少有一名队伍成员应观察测量和加入操作，以确保正确完成。

（3）加入完成后，小车应贴上标签。此标记应保留，直到实验完成。

2.3.27 带压设备中不含塑料

如果在小车上使用塑料，则必须通过制造商的数据对队伍使用的特定温度，压力、工作温度下的压力和流体或气体进行认证，并且数据必须在安全审查中呈现。

（1）聚氯乙烯硬管

聚氯乙烯塑料管，尤其是带有粘接或螺纹连接部件的此类管道，严禁在受压状态下使用。此前曾有过这种管道在受压情况下发生故障的案例，因此不允许再出现这种情况。

（2）塑料管材示例

经过特定制造商认证的塑料管材，在室温（25°C）条件下使用压缩空气时，其承受压力的上限为 200 psig（13.8 barg）。此管材在使用时不得超过特定温度（即 100 °C），除非制造商明确表明该管材已通过认证，可在 200 磅/平方英寸的压力和 100 °C 的条件下与压缩空气配合使用。

如果一种塑料管材被认证可用于 100 psig 压力和 25 °C 条件下的压缩空气输送，那么它就不能与其他气体（例如二氧化碳、氧气或其他气体）一起使用，除非制造商证明该管材在这些条件下对这些特定气体是适用的。

2.3.28 化学品容器

（1）主要容器

在小车正常送到起跑线期间以及在竞赛的小车操作期间，主要容器必须足以防止任何化学品的泄漏。盖子必须足够坚固，以在紧急情况下只能释放非常有限的化学物质，例如小车翻倒或碰撞。

（2）盖子

包含化学品的容器上的所有盖子必须牢固地连接到容器上，并且应覆盖整个容器开口。请确保盖子或容器上的任何孔都足够大，以容纳“通孔的物件”—如果可能的话密封。保鲜膜、铝箔和其他类似材料不能用作容器盖。此外，必须谨慎操作，以确保在非额定压力的容器内不会发生压力集中。

（3）二次容器

对于具有 GHS 健康或任何等级（1-4）的物理危害的易燃和反应性化学品，需要二次容器。小车上的二次安全容器必须具有合适的耐用性和尺寸，以便将任何溢出的化学物质保持在小车上。二次容器不强制要求有顶盖，但这是一种很好的做法。在小车准备区域的化学处理过程中必须采取适当的措施，以防止人体接触这些化学品—见化学品处理和处置附录 B。

2.3.29 温度危害

小车上温度高于 150 °F（65.5 °C)或低于 32 °F（0 °C) 的所有暴露在外的表面必须绝缘或覆盖，以防止与人体皮肤接触。

2.3.30 电气危险

所有接线和外露电气元件必须绝缘或覆盖，以防止电击或点燃小车任何部件。

不能使用鳄鱼夹，鳄鱼夹和绞合线将造成电击危险和易燃蒸气和液体的点火源，不允许使用。使用更坚固的电气连接器，如香蕉插头或接线柱。

学生自制电池的充电必须以安全的方式进行，并在 EDP 中进行记录。

2.3.31 机械危险

任何活动部件和夹点都必须有防护装置。这包括齿轮，皮带，连杆，致动器臂和可能呈现夹点的任何其他部件。

2.3.32 氧气

氧气环境中的所有组件必须由制造商对氧气进行评级，且评定/认证必须包含在 EDP 补充文件中。这包括容器，管道过滤器，调节器和阀门。优先选用金属，因为非金属更容易在有氧环境下燃烧。设备在此之前不得用于其他作用。特别是，用于烃类气体的气体调节器在进入含氧气设备时很可能会爆炸。

2.3.33 清洁

所有使用氧气的设备在投入使用前必须彻底清洁。有效的清洁有：去除颗粒，薄膜，油脂，油和其他不需要的物质，去除疏松的氧化膜，铁锈，尘土，防止焊接点脱落堵塞管路和影响部件正常工作。

降低更易燃的微小颗粒的浓度。需要将所有部件拆卸来清洁。依据被清洁的材料选择清洁液。

清洁程序必须作为 EDP 补充文件的一部分记录。

2.3.34 生物危害

如果在 Chem-E-Car 小车的设计，开发，操作，竞赛和准备的任何阶段使用任何生物有机体，它们必须不超过 1 级生物危害（也称为生物安全等级 1）。这将包括任何细菌，真菌，病毒或酵母生物。必须遵循适当的处理程序，以尽量减少生物组织与人体的接触。必须根据当地法规收集、包装和净化所有剩余的培养物，种群和其他受管制的废物。

2.3.35 事故处理

如果竞赛期间发生安全事故，将通知该队的 AIChE 学生分会指导老师，同时要求该队伍必须向地区赛竞赛安全委员会提交一份事故分析报告。本安全事故报告必须得到地区赛竞赛安全委员会的批准，方可允许该大学的任何队伍参加地区赛或年度学生会议 Chem-E-Car 竞赛。

2.3.36 竞赛当日规则

（1）个人防护用品（PPE）

每队必须如 JSA 中所示，提供适当的个人防护用品（PPE），以便在化学品

准备区域使用，并必须正确使用。包括实验服、安全眼镜、手套、面罩和听力保护设备。根据化学试剂使用过程中可能遇到的危险，所有队员必须正确使用个人防护装备。

（2）准备区内的电子设备

所有便携式个人电子设备在准备区都必须盖好。较小的便携式个人电子设备，如计算器，尤其是手机，必须在整个比赛期间保存在透明塑料袋（如保鲜袋）中。参赛队还必须在笔记本电脑和平板电脑的触摸屏和键盘上放置屏幕盖和一次性键盘盖。此规定旨在防止便携式个人电子设备受到污染。参赛队有责任为其便携式个人电子设备提供透明塑料袋、屏幕盖和键盘盖。如不遵守此规定，所有参赛队的电子设备将在比赛剩余时间内从准备区移除。

（3）带标签的容器

所有装化学品的容器，包括瓶子、烧杯、注射器和塑料袋，都必须贴上适当的标签。标签应至少包括化学品的名称，以及队伍的名称。

（4）实验台上溢出溶液收集器

在准备区域内的所有化学品倾倒或混合都必须有溢出溶液收集器。您的队伍必须使用一个与您的化学品兼容的大托盘，其容量足够容纳您的化学品的量。

（5）化学品发放

在性能竞赛开始至少 2 个小时前，所有的化学药品将在准备区域中提供给竞赛队伍。在竞赛开始前 3 个小时内，任何队伍不得使用化学药品，包括电池驱动的小车。任何在竞赛开始前一晚或超过 3 小时给电池充电的要求将不予受理。

（6）置于化学准备区的小车

比赛期间，每个参赛队只允许将通过现场安全检查的小车置于化学准备区。

（7）化学准备区的车辆测试

如果参赛队的小车已被放置在固定支架上，参赛队只能测试相关反应。车轮不允许在受驱动条件下接触固体表面（如桌面或地板表面）。

（8）实验废弃物处置方法

所有废弃物必须是以下五类：酸性，碱性，中性水相，有机相，固体废物。其中有固体废物排放的队伍必须将固体废物分离为 pH 6-8 的独立组分，并装在自己队伍的防水容器中。

参赛队伍必须在赛前完成团队的废弃物标签，并在 EDP 中提供。所有排放的废弃物都需要提供标签，废弃物标签应至少包括废弃物的描述，组成，浓度，体积，所属队伍和队伍号。

不遵守废弃物排放规则的队伍可能导致出现安全事故，可能被禁止参与未来一段时间的比赛，并需要提供事故调查报告。

2.3.37 请求协助

为保障小车安全而请求协助是无任何限制的。鼓励队伍向他们的教员顾问、其他教员、其他大学、其他队伍或行业和其他地方的专业从业人员请求额外的安全协助。

2.4 参考资料

National Fire Protection Association (NFPA). This method assigns a numerical value to the degree of hazard based on three major hazard groups: toxicity, flammability and instability/reactivity. The numerical values range from 0 to 4, with 0 representing the lowest degree of hazard and 4 representing the highest. See www.nfpa.org for more details on this.

National Institute for Occupational Safety and Health (NIOSH). An excellent source of information on the hazardous properties of chemicals. www.cdc.gov/niosh. In particular, they support a free, on-line guide to chemical hazards called the NIOSH Pocket Guide to Chemical Hazards. This is available at http://www.cdc.gov/niosh/npg/default.html.

Occupational Safety and Health Administration (OSHA) Information about Hazard Communication Standard (HDS), which is now aligned with the Globally Harmonized System of Classification and labeling of Chemical (GHS).
Information on Safety Dara Sheets, & labeling can be found at
https://www.osha.gov/dsg/hazcom/
Information on GHS can be found at
https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf

Crowl and Tipler, “Sizing Pressure-Relief Devices”:

https://www.aiche.org/sites/default/files/cep/20131068_r.pdf

NOTE: Equations (5) and (6) in Crowl and Tipler's "Sizing Pressure-Relief Devices" have a typo. The exponent (y+1)*(y-1) is incorrect, and instead should read (y+1)/(y-1)

SACHE module: Emergency Relief system Design for Single and Two-Phase Flow

AIChE Chem-E-Car Competition Safety Training Course:
www.aiche.org/chemecar

附录 A：压力容器测试流程

测试压力是利用水压测试来达到指定的目标压力。这个值取决于容器的最大工作压力是否已知。参见下面所示的压力容器测试要求。

必须彻底研究并记录制造商对车辆所有加压部件(尤其是塑料部件)的使用建议。这包括遵循制造商的材料使用建议。“

不允许使用任何塑料，例如禁止将 PVC、TygonTubing、cPVC、聚对苯二甲酸乙二酯 PETE)、ABS、PC 等用于加压容器或管道系统，或用于温度高于制造商建议温度的气体或液体。所有塑料都有被称为裂纹的微小缺陷，这些裂纹在应力的作用下会发展成裂缝，随着时间的推移会导致失效，从而造成危害。本规则不允许有例外情况。

A.1 压力容器试验规程

此处提供三种方案来针对不同情况：

（1）容器的最大工作压力（MAWP）已知，且使用时间不足 5 年，或者在过去 5 年内重新测试过，没有显示出任何腐蚀、磨损或滥用。在这种情况下，容器已经获得认证，所需要的只是获得与此认证相关的信息。有两种方法可以得到这个信息：

•压力容器已经带有 MAWP 的标签或包含一个指示 MAWP 的铭牌。这表明它之前已经进行了流体静力学测试。所以需要提交支持 MAWP 评价的文件，或清晰的铭牌照片或 MAWP 标签和测试日期。

•容器制造商通过技术规范提供容器的压力等级。在这种情况下，提供本规范的副本。容器的使用寿命也必须加以证明。这种情况下，压力认证所需的全部文件就是这些文件。

（2）容器的最大工作压力已知，且使用时间在 5 年以上，或者在 5 年内没有重新测试过，或者曾有过腐蚀、磨损或滥用的情况。这种情况有两种选择：

•使用商业公司通过水压试验重新测试 MAWP。提供与你的 JSA 重新认证相关的文件，包括测试的商业公司的名称和日期。

•使用下面所示的水压测试程序自行重新测试容器。这种情况下的测试压力是 MAWP 的 1.5 倍。参见下面的文档需求。

（3）MAWP 尚不清楚。这种情况适用于无标签/无证容器以及定制的压力容

器。这种情况只有一种选择：

•利用商业公司对容器的最大允许工作压力（MAWP）进行检测并进行水压试验。在 JSA 提供有关此认证的相关文件，包括测试公司的名称。参见下面的文档需求。任何最大允许工作压力（MAWP）未知的容器（无论是否为定制容器），其最大允许工作压力必须由商业机构或具备资质的高校水压试验装置进行认证。严禁学生自行认证此类容器的最大允许工作压力。本规则不允许有例外情况。

A.2 水压试验程序

水压试验（介质为水）是压力容器试验的标准。由于快速膨胀气体的爆炸性，不允许使用空气、氮气、二氧化碳或其他气体进行气动试验。

（1）压力计的要求

压力表的指示范围必须不小于测试压力的 1.5 倍，不大于测试压力的 4 倍。且仪表必须能够读取到至少 5psig 的变化量。

（2）容器变形测量

在压力测试期间，必须配置一个仪表来测量容器的任何变形。这个压力表必须对进行测试的操作人员可见。使用至少精确到 0.001 英寸（0.0254 毫米）的千分表。确保仪表处于良好的工作状态并正确校准。为了确认在增压过程中没有发生塑性屈服（膨胀），容器必须在水压试验前后沿着中心线（x、y、z）三个方向进行测量。测量应使用卡尺或机械表精确到 0.001 英寸或更小。

（3）测试区域

测试区域应加以限制和封锁。正在进行压力测试的容器应该朝向正确的方向，以便螺栓、法兰和其他可能的弹射物品远离人员和其他设备的方向。所有压力测试必须远程进行。在容器测试失败时（即容器发生膨胀爆炸时）必须使用一个屏障（沙袋、木材等）来限制飞出的物品。屏障应该围绕容器的四面，并延伸到容器的上方。

（4）测试程序

1. 提供一个排气口，让空气在充满水的时候离开容器。你也可以考虑在测试完成时提供一个底部排水管道来排水。

2. 把容器装满水，把空气抽走。在测试前，确保容器内已完全装满液体。

3. 首先，将压力增加到最大测试压力的一半。然后，将压力每次缓慢增加 0.1 倍测试压力，直到达到测试压力为止。最后的测试压力必须保持至少 30 分钟。

在试验过程中，压力应保持稳定，不得有明显变化。试验压力的 10%或 5psig 的变化是显著的。不应观察到漏水或滴水现象。

4. 然后，将压力降低到容器的工作压力，并保持目视检查所有接头和连接。不应观察漏水或滴水。

5. 在测试之前和之后进行适当的容器测量，精确到 0.001 英寸（0.0254 毫米）以内，以表明在增压过程中没有发生可检测到的塑性屈服形变。

（5）测试文件

提供下列文件以说明水压试验达到要求：

•容器或系统的信息

•MOP 或容器或系统的测试压力（如果已知）

•计划的测试压力

•有关计算过程

•测试开始的日期和时间

•测试完成或失败的日期和时间

•最大压力

•测试压力顺序图（可选）

•测试液体种类

•系统外部的温度

•测试液体的温度

•进行测试的组织

•参赛队伍的指导老师的签字以证明测试已经完成

（6）容器标签

在测试完成时，必须在压力容器上贴有压力测试标签。标签上的信息必须包括：

•容器信息（小车名、容器用途）

•MOP 或测试压力、温度

•容器的工作液体

•测试工程师

•测试日期

附录 B：化学品处理和处置

所有参加竞赛的学生，无论是在他们的主办机构，还是在区域或年度学生会议竞赛中，都必须了解所有化学物质的危险性质。在使用特定的化学品之前，必须始终牢记药品安全处理方法。教师顾问负责确保提供了安全使用化学品所需的设备。

B.1 化学品安全一般规则

（1）实验室必须提供所有化学品的安全数据表（SDS），包括实验室储存的化学品。

（2）购买化学品时，应购买完成计划实验所需的最小数量。因为处理未使用化学品的费用远远超过购买数量所节省的费用。

（3）皮肤直接接触化学品的操作一般必须避免。

（4）实验室内任何时候的可燃溶剂不得超过 2 加仑。散装易燃容器应当存放在易燃储物柜中。

（5）所有容器（包括在仓库中的容器）都必须贴上标签——具体要求见标签说明部分。任何未贴标签的容器都必须作为有害物质处理。

（6）处理强酸和强碱时，应戴上相应的手套和防护服。

（7）当易燃化学品进入储罐时，使用接地线和/或浸入腿。

（8）应当使用安全的运输工具来运输所有化学品。化学药品必须放在密闭容器中。

（9）化学容器必须远离高温、实验室工作台边缘以及其他可能导致容器丢失的区域。

（10）不允许用嘴吸或虹吸管来使用药品。

（11）未知物质必须被视为有毒和易燃药品处理。

（12）不要尝或闻任何化学品。

（13）涉及化学品的操作一般应在实验室通风柜内进行。

B.2 化学品存储

（1）所有储存的化学品都必须有有效的 SDS。

（2）所有储存的化学品必须贴上适当的标签。

（3）任何化学品不得存放在实验室工作台的顶部或室外。化学品不得存放

于视线高度以上，以防容器掉落。

（4）易燃和挥发性化学品必须储存在指定的易燃储物柜中。见安全设备部分关于易燃储物柜的说明。化学品的冷藏储存需要一个额定储存易燃物品的冰箱。

（5）酸和碱应分开储存。

（6）耐酸托盘应放置在储存酸的容器下。

（7）氰化物和硫化物等酸敏感物质必须与酸分离。

（8）可氧化材料应远离酸和碱。

（9）储存的化学品必须由实验室人员定期检查（至少每年一次），以检查是否变质、容器的完整性和过期日期。不使用的化学品应弃置或退回化学物品商店循环再造。

（10）储存的化学品必须由实验室所有人随时保有一份清单。剩余物应妥善丢弃或退回化工仓库。只存储正在使用的东西。

B.3 化学标签

所有化学品都必须贴上标签，即使是在临时运输期间。包括实验室样品、临时容器等。正确的化学标签必须包括：

•名称、地址和电话号码

•产品信息•关键词

•风险声明

•预防性说明•象形图

标签上必须有象形图，以提醒用户可能接触到的化学危害。每个象形文字由白色背景上的一个符号组成，并以红色边框框起来，代表一种独特的危险。下面是一些你可能会遇到的象形文字的例子。

B.4 化学品处理

所有化学品必须以安全和环保的方式处理。任何腐蚀性、可燃性、反应性、毒性、放射性、传染性、生物毒性、诱变性或极度危险的化学物质都必须作为危险废物处理。请勿在通风柜或洗槽内蒸发处理化学品。如果对材料的危害有任何疑问，请不要犹豫，立刻向专业人员请教。

在有清楚标示的容器内收集和储存化学废物。不要混合不同容器中的化学品，除非每个容器中的内容是已知的、兼容的，并且这样做是安全的。综合废物处理起来要困难得多，费用也高得多。

普通的废物，如纸、纸板等，可以放在废纸篓里。然而，受污染的废物必须

单独处理在一个有标签的容器。

空的化学容器也必须以可接受的方式处理。它们必须先被清洗干净，然后要么送回化学品仓库，要么作为普通垃圾处理。

附录 C：常见问答

1、问：组委会老师您好，为了精准控制小车行进距离，请问我是否可以在小车驱动回路中接入计时器或使用酸碱滴定反应？

答：同学你好，这两种行为都是不可以的。根据《2026 中国大学生 Chem-E-Car 竞赛官方规则》1.3.4.7 中第十条关于禁止使用机械或电子计时装置的描述，计时器是禁止在驱动回路中使用的；同样，瞬时反应也被认为是计时装置，也是禁止使用的。

2、问：裁判老师您好，我们担心小车在运输途中机械系统发生改变，可不可以提前一晚在宾馆试跑一下？

答：同学你好，提前试跑是不可以的。根据《2026 中国大学生 Chem-E-Car 竞赛安全规则》2.2.5 的关于“违规的小车调试”描述，在酒店或宿舍走廊等不具有化学处理能力的场所是绝对禁止进行小车测试的，如果被发现违规试跑，您的参赛队将面临禁赛处罚。

3、问：裁判老师您好，我们担心参赛的本科同学无法讲清我们的海报细节，可否请我们的指导老师协助讲解？

答：同学你好，这种行为是不合规的。根据《2026 中国大学生 Chem-E-Car 竞赛官方规则》1.3.4.11 中关于队伍成员和身份的第四条描述，规则和安全审查员在安全审查和海报竞赛上提出的所有问题必须由本科学生队伍成员回答，解释小车设计，操作，安全和规则合规性的能力是本科生的责任，所以指导教师协助讲解是不被允许的。

4、问：裁判老师您好，我们发现用步进电机作为小车的驱动电机，小车的运行十分稳定，是否可以在比赛中也采用步进电机作为驱动电机呢？

答：同学你好，这种情况是不可以的。步进电机是将电脉冲信号转变为角位移或线位移的开环控制元件。在非超载的情况下，电机的转速、停止的位置只取决于脉冲信号的频率和脉冲数，而不受负载变化的影响，即给电机加一个脉冲信号，电机则转过一个步距角。因此它可以认为是含有编码器元件的电机。根据《2026 中国大学生 Chem-E-Car 竞赛官方规则》1.3.4.7 第八条中对小车设计禁止使用编码器的描述，步进电机是禁止作为小车驱动电机使用的。

5、问：老师您好，在准备阶段，可以让小车接入替代电机进行测试吗？

答：同学你好，这种行为是违反规定的。根据《2026 中国大学生 Chem-E-Car 竞赛官方规则》1.3.4.7 中第四条的描述，在小车放置在起跑线之前，禁止动力系统空转，任何测试都是不可以接入电机的。

6、问：在比赛过程中，指导老师可以在场外指导吗？

答：同学你好，不提倡这种行为。在比赛过程中，参赛的同学应当独立完成实验准备，场外指导会给其他队伍带来诸多不便，只有在准备区的同学能参与实验准备。

7、问：组委会老师您好，为什么我们参赛队的 EDP 评审意见中会包含“禁止在小车设计上使用注射器”呢？

答：同学您好，根据《2026 中国大学生 Chem-E-Car 竞赛安全规则》2.2.13 中的第二条描述，任何容量的注射器（以及延长针）都不允许在小车设计中使用。这一规则的改变也是为了促进更好、更安全的设计。所以注射器是无法在小车设计中使用的，但在其余情况的使用（如准备实验中用注射器移取液体）仍然是允许的。

三、附 2026 美国官方规则（英文原版）

附件 1：2026AIChEChem-E-Car 竞赛官方规则（英文原版）

Calendar Year 2026 Competition Official Rules (inclusive of Student Regional Conference and Annual Conference)

<table>
<tr><th></th><th>Date</th><th>Checklist of Important Deadlines</th></tr>
<tr><td>□</td><td>August 1st – October 31st, 2025</td><td>Learn about the Annual Student Conference at www.aiche.org/asc

Review Chem-E-Car Competition Rules, EDP Document & Safety Training information at https://www.aiche.org/students/chem-e-car-competition/chem-e-car-competition-rules

Submit questions at www.aiche.org/chemecarquestions. For questions about rules, be sure to select that your question is about either the Competition Rules or Safety Rules on the form.</td></tr>
<tr><td>□</td><td>February 21th – August 1st</td><td>All teams are required to complete and submit an Engineering Documentation Package (EDP) 5 weeks before competition date.

Teams will receive EDP Review Feedback on the safety aspects of their design so they can prepare for the On-Site Safety Inspection.

Submission links and deadlines can be found in the table below.
<table>
<tr><th>Region</th><th>EDP Submission Link & Deadline</th><th>Conference Dates</th></tr>
<tr><td>North Central</td><td>February 21st</td><td>March 27-28, 2026</td></tr>
<tr><td>Southwest</td><td>February 21st</td><td>March 27-28, 2026</td></tr>
<tr><td>Mid-Atlantic</td><td>February 21st</td><td>March 28-29, 2026</td></tr>
<tr><td>Southern</td><td>February 28th</td><td>April 3-4, 2026</td></tr>
<tr><td>Mid-America</td><td>March 6th</td><td>April 10-11, 2026</td></tr>
<tr><td>Rocky Mountain</td><td>March 6th</td><td>April 10-11, 2026</td></tr>
<tr><td>Pacific Northwest</td><td>March 6th</td><td>April 10-12, 2026</td></tr>
</table></td></tr>
</table>

		Eckhardt Northeast	March 13th	April 17-April 18, 2026
		Western	March 20th	April 25-26, 2026
		Latin America - Procesa	April 8th	May 13-16, 2026 *(tentative)*
		India	TBD	TBD
		Brazil	TBD	TBD
		Indonesia	TBD	TBD
		Saudi Arabia	TBD	TBD
☐	**Competition Weekend**	Bring all items to On Site Safety Inspection & Competition • Poster • Printed EDP, EDP Supplement and MOC Form in binder/folder • Printed EDP Review Feedback • Printed Waste Tags to use at competition • Chem-E-Car • PPE for all team members • Portable personal electronic device covers		

Summary of Changes

January Changes to Competition Rules

a. New award added for Annual Student Conference competition

January Changes to Safety Rules

a. Maximum allowable concentration of acetic acid reduced from 60% to 50% (19.)
b. Pressure definitions and limits clarified by tying MAWP to the weakest system component at a specified temperature (21.1.1) and capping MOP at 200 psig at any temperature (21.1.2)
c. Restrictions clarified for 26. No Plastic in Pressure Service
d. The use of PVC rigid pipe under pressure is explicitly banned (26.1)
e. **The Chem-E-Car Committee would like to provide advance notice that in the January 2027 rule set, lead-based batteries will no longer be permitted (17. Disallowed Chemicals)**

January Changes to Appendices

a. Appendix A (3) – requires vessels with unknown MAWP to have their MAWP certified by a commercial firm, eliminating option for teams to self-certify

January Changes to EDP Template

a. (a) Pressure section of Hazard checklist updated to align with changes to rules regarding pressure, including requirement of all car components to operate at a MAWP greater than the MOP and requirement that Plastic tubing in pressure service have manufacture documentation for actual pressure service

Chem-E-Car Competition Overview

The objectives of the AIChE Chem-E-Car Competition:

- To provide chemical engineering students with the opportunity to participate in a team- oriented hands-on design and construction of a small chemical powered model car;
- To demonstrate the ability to safely control a chemical reaction by changing the amount or concentration of a chemical species (reactant, catalyst, or other species that has a direct relation to the control of a chemical reaction);
- To design and construct a car that is powered with a chemical energy source that will travel a given distance and stop;
- To encourage students to become actively involved in their professional society;
- To increase awareness of the chemical engineering discipline among the general public, industry leaders, educators and other students.

There are two general competitions. The first is held at regional conferences and the second is held at the Annual Student Conference at the site of the AIChE Annual Student Conference.

No chemical or mechanical work should be completed on your car until an initial safety review has been conducted by your Chem-E-Car Advisor or outside expert. The Safety Training Course & Quiz training should also be completed before you begin work.

Please note that the Regional Competitions and Annual Competitions are separate competitions. Passing the safety inspection at the Regional Chem-E-Car Competition does not guarantee that your team will pass the safety inspection at the Annual Student Conference Chem-E-Car Competition. Additionally, you will not have access to the same resources at the Annual Competition that you might have at the Regional competitions and vice versa. Fume hoods and air compressors will not be available at the Annual Competition. If you have any questions about what will be available to you at Annual, please reach out to the Chem-E-Car Committee via the Questions Form.

All Chem-E-Car Teams must be from active Student Chapters that submitted a Student Chapter Annual Report online to AIChE. Visit www.aiche.org/studentchapterannualreport to submit a report.

There is a poster session, safety inspection and a performance session at each competition, as detailed below.

During the competition, each team will be asked to introduce its entry to the audience, giving the school name and briefly discussing the propulsion and stopping mechanisms. Teams will also have the opportunity to submit a video showcasing their team at the Annual Student Conference competition.

Regional Conference Competition

- Schools may be limited to one entry per University, at the discretion of the Regional Conference Host Chapter and Regional Safety Coordinator

- The official rules listed apply for the regional conference competition and the Annual Student Conference Competition.
- An AIChE-appointed safety and rules coordinator will attend each regional competition. This coordinator is the final authority regarding Chem-E-Car Competition® rules, safety concerns, violations, disqualifications, and the like, for that Regional Competition only.
- The coordinator's judgment applies only to the regional competition and is not binding on judgments at the competition at the Annual Student Conference.

Regional Conference Awards

Sponsored by 

- **Performance Competition:** 1st place: $200 & 2nd place: $100
- **Poster Competition:** 1st – 3rd Place: Certificates

Annual Student Conference Competition

The top teams from Regional Chem-E-Car Competitions will be awarded the opportunity to compete at the global competition taking place at a future AIChE Annual Student Conference in the United States. This is the only way to earn an invitation to this global event.

North America Regionals

- Mid-America: Top 3
- Mid-Atlantic: Top 5
- North Central: Top 5
- Northeast: Top 3
- Pacific Northwest: Top 2
- Rocky Mountain: Top 3
- Southern: Top 5
- Southwest: Top 2
- Western: Top 3

International Regionals

- Brazil Top 1
- China Top 3
- Latin America Top 1
- India Top 2
- Indonesia Top 1
- Middle East Regional Top 3

Only one entry per school, via this qualifying procedure, will be allowed at the Annual Student Conference competition no matter how many compete at regional competitions

NOTES:

- If your team participated in a regional conference but did not qualify for Annual, or if your team is located in a region that does not offer a regional conference, you may fill out the Chem-E-Car waitlist form, released annually and linked here, to be added to the waitlist sometime in July or August of each calendar year.

Annual Student Conference Competition Awards

Sponsored by  *and the* ***H. Scott Fogler Endowment Fund***

The **Annual Student Conference** Competition associated awards are:

- **The H. Scott Fogler 1st place award:** $2000 USD and a trophy
- **2nd place:** $1000 USD and a trophy
- **3rd place:** $500 USD and a trophy
- **4th & 5th place –** trophy
- **Best Use of a Biological Reaction to Power a Car** *sponsored by the Society for Biological Engineers*- $500 USD
- **SAChE Safety Award** *for the best application of the principles of chemical process safety* - trophy
- **Spirit of the Competition** *for the team displaying the most team spirit as decided by a panel of judges*- trophy
- **Most Innovative Car Design** *to be decided by judges* - trophy
- **Golden Tire Award** *for the most creative car as decided by the teams*- trophy
- **Best Video –** trophy
- **Chem-E-Car Poster Award** – 1st- 5th place- trophy
- **Outstanding Sportsmanship Award-** trophy
- **Best Team Name-** trophy
- **Chem-E-Car MathWorks Modeling and Simulation Award 2026** *for teams that excel in utilizing MathWorks tools for the design and simulation of their Chem-E-Car, sponsored by MathWorks* - trophy

Chem-E-Car Competition Poster Session & Safety Inspection Rules

1. **Poster overview:**
   - 1.1. A poster board must be displayed with the autonomous vehicle on the day of the competition. This poster should clearly describe:
     - How the car is powered by a chemical reaction
     - How it stops on a chemical reaction
     - Unique features of the car
     - Environmental and safety features in the design
     - Vehicle design description, drawings and testing results

2. **Team Members:**

2.1. The poster competition and judging will occur prior to the Chem-E-Car Performance Session. Team members must be present during judging to answer questions from the judges.

3. **Minimum Score:**
   3.1. A team must achieve a passing score in the poster competition to be able to advance to the Chem-E-Car Performance Competition. Posters will be judged according to the following criteria:

- Quality of the poster and team member presentations (50%)
- Design creativity and unique features of the vehicle and safety considerations (35%)
- Demonstration of knowledge of reactions, calibration methods by all team members, and ability by team members to answer questions posed by the judges (15%)

4. **Winners:**
   4.1. Winners of the poster competition will be announced at the end of the performance competition.

5. **Safety inspection:**
   5.1. During the poster competition, an audit team will inspect each vehicle to ensure that all of the safety requirements have been met and that the vehicle will operate without risk to the operators, contest staff and spectators.
   5.2. If the audit team deems the vehicle safe to operate, then the vehicle will be given permission to compete.
   5.3. This permission is not automatic and must be earned by adhering to the guidelines/procedures outlined below. If a car is deemed unsafe, then it will not be given permission to compete.
   5.4. The Chem-E-Car Competition Safety Judges at the competition site have the final say in regard to permission to compete, regardless of whether a car was given permission to operate at a previous Regional competition.

Chem-E-Car Competition Performance Session Rules

6. **Distance**
   6.1. Each car will be given two opportunities to traverse a specified distance.
   6.2. The required distance will be given to each team one hour prior to the start of the performance competition. The distance will be between 15 and 30 m ± 0.005 m.
   6.3. Teams may not make significant changes to their vehicle once the poster session has concluded, unless they have prepared, and have an approved management of change (MOC). Teams are only allowed to change the amount or concentration of one or more chemical species used in the car's chemistry.
   6.4. The distance will not change for the final round.

7. **Course Layout and Distance Measurement**
   7.1. The course will be no more than 5 meters wide in a straight line. *For regional conferences the course may be less than 5 meters wide, depending on the university track location.*
   7.2. At the Regional Competitions only 1 track will be used. At the Annual Student Conference Competitions, 2 identical tracks will be set up and run in parallel.

7.3. The car will start with its front end just touching the designated starting line, with the goal of keeping the car in bounds to a designated finish line. The performance is determined by the distance from the front-most point of the car to the finish line, whether or not the car stops before or after the finish line.
7.4. A vehicle that goes out-of-bounds on the left or right side will be *given a penalty for that run of +3 meters.*
7.5. *"Out of bounds" is defined as when any part of the car touches or crosses the boundary. If tape is used to mark the side boundary or the out-of-bounds after the finish line, the inside edge of tape is considered the course boundary (If a wall is set as track boundary then contact with the wall is out of bounds).*
7.6. If the car starts going backwards at the starting line, the score will count as 0 m traveled.
7.7. The site location may also dictate an out-of-bounds region past the finish line. Vehicles traveling across the plane of the out-of-bounds region will be disqualified for that attempt.

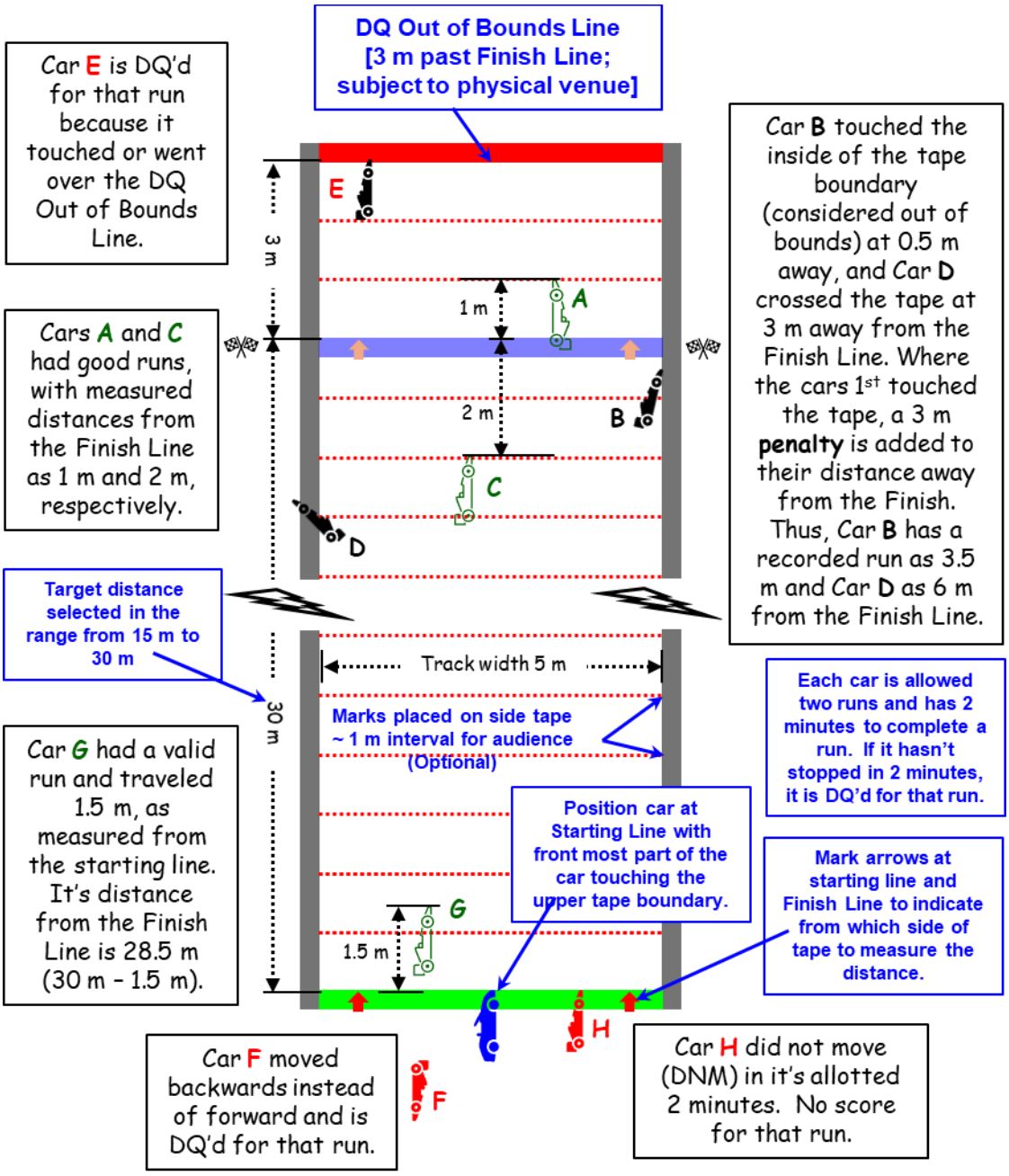

Figure 1: Performance course layout including sample scoring scenarios

8. **Race Logistics**
   - 8.1. A Chem-E-Car Competition® judge (or MC) will announce each team just prior to the start of their attempt.
   - 8.2. Each car will have two (2) attempts to complete the course. Each attempt is limited to a two (2) minute time limited for the car to start and completely stop. Any car that does not stop within the two minutes will be disqualified for that attempt.
   - 8.3. The best score of the two attempts will be used to determine the winner.

8.4. In the event that a team fails to show up on the starting line, or the vehicle fails to start, the next team in the order of the competition will be announced and requested to proceed to the starting line immediately.
8.5. The competition order will not change between the first and second rounds. There will be a short 15 minute break between rounds of the competition.

9. **Starting Line Procedure**
   9.1. The car must start moving, traverse the distance, and come to a stop within a 2 minute time interval.
   9.2. At the starting line, 1 team member will be asked to head to the finish line. Team members are responsible for picking up their car after the distance is measured.
   9.3. Once the car is placed on the starting line and the 2 minute time interval begins, all wheels must remain on the ground. Pushing the car or picking up the car/part of the car will result in a disqualification for that attempt.

10. **Competition Order Logistics**
   10.1. The distance and run order is announced one hour before the competition starts.
   10.2. If a car is disqualified that was scheduled to start before your car, then you will move up one position in the starting order.
   10.3. Five (5) minutes before the start of the competition, the first three (3) teams for each track are called to the start. The first team for each track will be at the starting line, the second team at the ready table, and the third team prepared to move to the ready table.
   10.4. The first team is given a one-minute warning before the competition starts.
   10.5. Each team is given two (2) minutes for the car to start moving from the time they are called to the starting line.
   10.6. Cars are permitted two (2) minutes to traverse the distance and stop.
   10.7. The timing will also stop if the car travels out of bounds.
   10.8. If the car does not stop within the two-minute period, then it is disqualified from that round of the competition.
   10.9. After the car stops, its distance is measured. Once the distance measurement is completed, the next team moves from the ready table to the starting line.
   10.10. Repeat 10.5 – 10.9 for the remainder of the competition.

11. **Vehicle Drive System**
   11.1. An objective of this contest is for students to demonstrate the ability to control a chemical species (reactant, catalyst, or other species that has a direct relation to the control of a chemical reaction).
   11.2. The only energy source for the propulsion of the car is a chemical reaction.
   11.3. The distance a vehicle travels must also be controlled by a chemical reaction, based on a quantifiable change and direct control of the concentration of a chemical species.
   11.4. This chemical reactant species must be a solid, liquid, or vapor.

12. **Vehicle Design**
   12.1. Vehicles entered into the competition must have a significant and demonstrable student design component, particularly with respect to the vehicle drive system, and the starting and stopping mechanisms.
   12.2. Both the chemical reaction propelling the vehicle and the start/stop reaction (if there is one) must be physically on the vehicle during the competition (i.e., pre-loading of a drive system such as a capacitor assembly is not allowed).

12.3. The vehicle must be powered by a chemical reaction and must be stopped by a quantifiable change, and direct control, of the concentration of a chemical species.

12.4. This chemical reactant species must be a solid, liquid, or vapor.

12.5. **Autonomous vehicle:** The car must be an autonomous vehicle and cannot be controlled remotely. Pushing to start the vehicle is not allowed. Any forward movement of the car at the start not related to the chemical reaction will lead to disqualification. "Bleeding" the time off at the starting line or prior to the starting line is prohibited. Raising the vehicle at the starting line to allow the wheels to begin turning is not allowed.

12.6. **On-board computer control system (ex Arduino or Raspberry Pi unit)** are allowed but must not in any way control/ measure the distance traveled. The program must be loaded onto the controller/computer/processor prior to the competition, and the settings may not be changed after the competition begins, **which is defined as the time when the distance is announced.**

12.7. Wired or wireless communication with the on-board computer/controller is not allowed once the competition begins and during the competition.

12.8. Teams may be asked to provide a copy of their complete programs to the rules committee on the competition day.

12.9. **Encoders:** Teams are also not allowed to use an encoder to regulate the velocity of the vehicle in order to control the distance.

12.10. **Voltage regulators:** Teams may not use a voltage regulator to modulate the voltage/amperage from their propulsion system reaction to their car's motor. MOSFETs, H-Bridge Motor Drivers, MOSFET triggers, transistors, Zener diodes, voltage or current limiters, rapidly changing relays (relays used as simple on-off switches with no toggling is OK), capacitors, and the like are not permitted. Any component used to step up, step down, or smooth out power (this includes voltage and/or current) from your battery to your motor is considered a "voltage regulator" under this rule.

12.10.1. This change was intentional. Not to remove batteries, but to stimulate creativity. The goal of the competition from when it was conceived by Dr. Fogler was for the chemistry to control the distance the car travels, not the electronics, Arduinos, or microprocessors.

12.10.2. You may measure voltage and/or current and fully cut power in order to protect equipment from over energization. The power may not be toggled back on after it has been cut.

12.11. **No Mechanical brakes:** No mechanical force can be applied to the wheel, gears, driveshaft, etc., or ground to slow or stop the car (e.g. no brakes).

12.12. **Mechanical or electronic timing devices:** There can be no mechanical or electronic timing device(s) to stop the chemical reaction or stop the car. In addition, a timing device cannot utilize what is normally considered as an instantaneous reaction. *For example, a constant or draining liquid feed to a sensing cell that employs an instantaneous reaction (such as acid-base or precipitation) would not be allowed. Another example would be a liquid draining out of a vessel to serve as a stop switch. This would be considered a mechanical timing device and would not be allowed.*

12.13. **ICE:** Internal combustion engines using an alternative fuel (e.g., biodiesel, ethanol, etc.) are allowed. The fuel MUST be completely synthesized by the students (no additive blending is allowed). *Succinct safety procedures for the maintenance and operation of this engine must be demonstrated by the team, with considerations to indoor operation. Internal combustion engines are not allowed to emit visible combustion smoke to the competition space and are subject to sound restrictions. See the Safety Rules for a more complete discussion.*

12.14. **Thermo-Electric Device (Power system):** Thermo-electric thermopiles purchased from a manufacturer must be run with at least one side (hot or cold) controlled by a chemical

reaction. *NOTE: Phase changes (including melting and crystallization), mixing and dissolutions are not considered a chemical reaction.*

12.15. **Fuel Cells:** Any vehicle that is purchased from a vendor without major modifications to its operation will be disqualified. For example, a team could not purchase a fuel cell car and race this car without any modifications. Any team that purchases a commercial fuel cell or builds their own fuel cell must synthesize the fuel that is used; example, if the team purchases a commercial methanol fuel cell, they must synthesize the methanol and provide verification of their procedure. Hydrogen for fuel cells MUST be generated by a chemical reaction on site or on the vehicle and not from a commercial device or pre-loaded canister. Appropriate process safety must be followed during fuel synthesis. The synthesis procedure must be clearly defined in the EDP.

12.15.1. Fuel cells with an internal voltage regulator are not permitted (see rule 12.10)

12.16. **Commercial batteries:** No commercial batteries of any kind (for example, AA batteries) are allowed as the power source used to move the car. Commercial batteries are allowed for specialized instrumentation (e.g. detectors, sensors, valves, mixing, pumps).

13. **Size of Car**

13.1. All components of the car must fit into a box of dimensions no larger than 40 cm x 30 cm x 20 cm. The car may be disassembled to meet this requirement.

13.2. If the judges are uncertain whether the car will fit inside the box when dissembled, they may request that the team demonstrate that they can do this.

14. **Capital Cost of Vehicle:**

14.1. The cost of the all vehicle components and the chemicals must not exceed $3500 USD. *The vehicle cost includes the donated cost of any equipment.*

14.2. The time donated by university machine shops and other personnel will not be included in the total price of the car. It is expected that every university has equal access to these resources.

14.3. The cost of pressure testing is also not included in the capital cost of the car.

14.4. The method used to estimate the donated cost of the equipment must be shown. It is expected that standard financial procedures will be used to estimate this cost.

14.5. Teams are required to include their vehicle's capital cost in their EDP.

15. **Changes to Car Design from Previous Years**

15.1 If a team competes at the AIChE Annual Student Conference Chem-E-Car Competition (for example, in 2025), the team must make substantial changes to both the propulsion system and stopping mechanism the following calendar year (i.e., in 2026).

15.2 Whether a change is sufficiently "substantial" will be up to the discretion of the Chem-E-Car Committee. For example, changing the acid in a sodium-bicarb and acid reaction will not be considered a "substantial change".

15.3 Structural improvements to the car chassis or reaction chambers are encouraged whenever necessary but will not be considered a significant enough change without a change to the propulsion system and stopping mechanism chemistry

16. **Team Member Status and Conduct**

16.1. All team members present must be active AIChE members and must be registered for the Student Regional Conference or Annual Student Conference where the competition is

taking place.

16.2. Faculty and graduate students can only act as sounding boards to student queries. The faculty cannot be idea generators for the project.

16.3. There is no restriction on requesting assistance on vehicle safety – teams may request safety assistance from their faculty advisor, other faculty members, other universities, and professional practitioners in industry and elsewhere.

16.4. All questions posed by rules and safety judges at the safety inspection and poster session must be answered by the undergraduate student team members. The ability to explain car design, operation, safety and/or rules compliance is the responsibility of the undergraduate students.

16.5. The students working on the project must sign a statement saying they have read, understand, and abided by the rules. This statement must be included in the EDP.

16.6. During the performance competition session, only five (5) team members are allowed in the pit area at once. Team members can be swapped out during the competition.

16.7. All team members and the faculty advisor MUST have completed the required safety training course, which is available at www.aiche.org/chemecar. All participating students must retake the course annually.

16.8. All student chapter teams that are competing in the Chem-E-Car Competition must have submitted a Student Chapter Annual Report online to AIChE. *Note: New AIChE Student Chapter established after January 1, are exempt from this requirement.*

17. **Winning Team and Awards**

17.1. The winning team is the car that stops closest to the competition distance. This is defined as the absolute value of the distance between the front-most part of the car and the finish line, whether or not the car stops before or after the finish line.

17.2. In case of ties, the team with the best average from the two attempts may be declared the winner.

17.3. Winners of the Chem-E-Car Performance Competition will be known immediately following the performance competition.

18. **Onsite Safety Judges and Rules Coordinators:** If there is any uncertainty on an issue of safety or other judging criteria, please contact the Chem-E-Car Committee. The decisions of the onsite rules and safety judges are final.

Calendar Year 2025 Competition Safety Rules

Chem-E-Car Safety Program Overview

The objectives of the AIChE Chem-E-Car Competition Safety Program are to ensure the safe preparation and operation of vehicles during all phases of the competition, including construction, testing and the competition. An audit of your system design and safety compliance will be conducted from the documentation your team provides.

The safety audit of your vehicle will occur in two stages:

- Online audit where teams will submit a fully completed Engineering Documentation Package (EDP) electronically and receive feedback. A member of AICHE staff will communicate EDP instructions to all teams. Failure to meet the posted deadline and by not submitting a **fully completed** EDP will result in exclusion from the competition. The EDP template is available for download on the Chem-E-Car Competition Rules Website at https://www.aiche.org/students/chem-e-car-competition/chem-e-car-competition-rules.
- Onsite Audit on competition day where teams must bring printed EDP, EDP Supplement, EDP feedback and MOC Form in a folder or binder and be ready to answer questions from safety reviewer Failure to pass this stage of the competition will result in receiving a disqualification from the competition.

Competition Safety Rules

1. **Safety Audit: Online**
   - **1.1. EDP.** An engineering documentation package (EDP) for your Chem-E-Car must be **fully** completed and submitted by the posted deadline. Use the EDP Template found on the AIChE website (EDP Template Link). Please rename the title of the EDP Template using the format UniversityName-EDP.pdf. Example: ***OregonStateUniversity-EDP.pdf*** A complete EDP will include the following in the following order:
   - **1.1.1. Job Safety Analysis:** Includes a description of your car and how it works.
   - **1.1.2. Photos:** Pictures of your vehicle after construction has been completed. These pictures must be current. The entire car must be visible in the picture. Remove the top to expose electrical controls if necessary. Multiple detailed views of the car are required. *A drawing or AutoCAD document is NOT acceptable.*
   - **1.1.3. Safety Training and Rules Certifications Page:** This page must be signed by all team members and your faculty advisor. Judges will use this page to determine: (1) If the starting and stopping mechanisms are compliant with the rules, (2) If everyone

has completed the required safety training and (3) that you have identified the major hazards and have controlled them properly. The certification page must be signed by the date of the competition. *Note that your group must have a minimum of 10 hrs. of operating time on the car prior to the faculty member signing. Note: The time you spend building the car cannot be counted as operating time.*

1.1.4. Hazards Analysis: Complete all pages, including attaching the floor plan/diagram of the laboratory where you are building your car.

1.1.5. Chemical Information: Includes a description of the chemistry involved, and a list of chemicals to be sent to the competition if in person, or to be used at the competition, if virtual

1.1.6. Chemical Hazards and Disposal: This section requires your team to conduct chemical research related to the chemicals you handle. List the properties for every chemical. Refer directly to the SDS for this information Resources like the NIOSH pocket guidebook, CAMEO, and New Jersey Hazardous Substance Fact Sheets can be used for supplemental information as needed.

1.1.7. Standard/Safe operating procedures page: Provide step-by-step details for the safe run prep, starting line procedure, shut-down, and clean-up of your vehicle. This page should be detailed enough so that someone unfamiliar with your vehicle should be able to safely prepare solutions for and operate it.

1.1.8. Equipment Table: A complete list of every piece of equipment on the car <u>in table format</u>, including the manufacturer of each piece of equipment. *Include operating limits (max temperature and pressure) for each piece of equipment, and ensure material compatibility where pertinent. When manufacturing spec sheets are absent, students should rely on the material properties for these limits.* Include a CAD or other diagram indicating where each piece of equipment is located within the design of your car. Use the same naming scheme in the diagram as in the equipment list. If your car has electronic circuitry, include a circuit diagram indicating components according to the equipment list.

1.1.9. Pressure: For Cars with Pressure Greater than 5 psig (0.345 barg): *Please complete and add the following to your EDP document*: A quantitative design basis for pressure relieving load; Sizing calculations for a pressure relief device; and Test procedure and results for a pressure relief. *Please see Appendix A of the Safety Rules for full instructions on what is required for Pressure Testing.*

1.1.10. Hydrogen gas discharge calculations (include for any flammable component). If you are using hydrogen gas, and plan to discharge a small amount, you must provide calculations demonstrating that the discharge stream is below 1/4 the LFL when mixed with ambient air. State any assumptions you make regarding the ambient air flow rate. As an example, if the LFL is 10%, the safe discharge would be under 2.5%.

1.1.11. Management of Changes to the car: After the online EDP review, you must complete any changes suggested by the EDP Reviewer and document these changes according to the process you outline. At a minimum, this should include a Management of Change (MOC) form available through AIChE. **This MOC must be presented during the onsite safety inspection.**

1.1.12. Capital Cost of Vehicle Calculations: Referencing the competition rule surrounding Capital Cost of Vehicle, use the space to show the capital cost of your vehicle and all related calculations.

1.1.13. Team Waste Tags: Please fill out a waste tag fully describing each of your competition day waste streams, using the forms in the EDP Template. These must be completed and included with your EDP. You must print and bring enough copies to accommodate all the waste you might generate. A completely filled out waste tag will be required before any team is allowed to dispose of waste into an AIChE waste collection system. NOTE: ALL SOLID WASTE MUST BE DISASSEMBLED, MADE SAFE AND BE LIQUID FREE

1.2. EDP Supplement. Please combine the following information in another single, separate PDF and should be titled "UniversityName-EDP-Supplement.pdf". Example ***OregonStateUniversity-EDP-Supplement.pdf*** . This helps the EDP reviewers to locate both files on the AIChE website easily. If for some reason you must submit a revision please follow this example naming: ***OregonStateUniversity-EDP-Supplement-V2.pdf*****.** NOTE: the first page of your EDP Supplement should be a Table of Contents, with the headings listed below. Please create sub numbers for each SDS and Manufacturer's equipment, so that it is easy for you and reviewers to find each item.

- **1.2.1. Safety Data Sheets** (SDS) made or revised after 2012 for all chemicals used or generated by reaction.
- **1.2.2. Manufacturer's specification documents** or specifications for custom-built components. For any commercial or custom built components, students must list material and compatibility.
- **1.2.3. Safety Training Course Certificates** for each team member + advisor
- **1.2.4. Any additional information** you need to save regarding your EDP that is not contained within the original EDP document.

2. Safety Audit:

2.1. Onsite (In-person). On the day of the competition, an audit team will inspect each vehicle to ensure that all of the safety requirements have been met and that the vehicle will operate without risk to the operators, contest staff and spectators. The Safety Judges at the competition site have the final say in regard to permission to compete, regardless of whether a car was given permission to operate at a previous regional competition.

2.2. Permission to compete. If the audit team deems the vehicle safe to operate, then the vehicle will be given permission to compete. If a car is deemed unsafe, then it will not be given permission to compete therefore rendering it unfit to run during the performance competition.

3. Disallowed Chemical Handling/ Illegal Chemical Transport & Storage

3.1.1. Transport Chemicals. Teams are not allowed to transport hazardous chemicals by car to the competition site. No chemicals shall be transported in private, university or rental vehicles to or from the competition site, even over short distances.

3.1.1.1. **Household Chemicals.** Common household chemicals, in the concentration in which they are sold, such as baking soda, vinegar, etc., are exempt from this rule. To qualify as a common household chemical, the chemical must be available for purchase and pickup from a retail location such as a grocery or

hobby store. Your team assumes all liability for safely and legally transporting these household chemicals.

3.1.2. Shipping Chemicals. Chem-E-Car teams should work with their University EHS (Environmental Health and Safety – or similarly named) department to make sure everything is shipped according to all DOT Hazardous Material Shipping laws. Make sure everything is properly labeled.

3.1.2.1. All hazardous and/or regulated chemicals that are shipped to a competition site must be shipped in their original packaging with all labeling from the supplier intact and legible.

3.1.2.2. No chemicals will be shipped back to a team or their university after the competition.

3.1.3. Illegal Chemical Storage. Chemicals must not be stored in hotel rooms or other facilities not rated for chemical storage. The exception to this rule is common household items such as baking soda and salt.

3.1.4. Student Made Batteries: *No student or team may transport or ship a student made battery that contains hazardous materials within the battery casing (i.e. a premanufactured lead acid battery containing acid). Doing so is in direct violation of Rule 3.1.1 Transport of Chemicals.*

3.1.4.1. Students may transport battery components provided they are non-hazardous and have been cleaned, neutralized, and made safe from any previous use.

4. No Compressed Hydrogen Gas Cylinder Usage

4.1. Hydrogen Generation. All hydrogen used on the vehicles (for instance with fuel cells) must be generated on-site or on the vehicle keeping the pressure below 5 psig (0.345 barg). Appropriate safety precautions and safe operation must be demonstrated. (See safety rule 10 regarding the need to purge air/oxygen from systems containing hydrogen. Hydrogen generation cannot begin until chemicals are given out on competition day.

4.2. Commercial Hydrogen Storage Canisters. Filling of vessels from a compressed hydrogen gas cylinder or commercial hydrogen storage canisters (such as hydrostiks or solid–core hydrogen cartridges) will not be allowed.

5. Illegal Testing of Vehicles

5.1. Testing Location. Testing of vehicles must only be done in a laboratory or other facility with chemical handling capability. Testing in hotel or dorm hallways, warehouses, or other facilities that are not designed for chemical handling is not allowed. No mixing of chemicals, including common household chemicals is allowed in the hotel or in dorm hallways.

6. Disposal of Chemicals. Disposal of waste represents both significant risk and cost to the competition. Teams are expected to be knowledgeable in all of their generated waste streams. All chemicals shipped to and waste generated from the competition site must be disposed of in a safe and environmentally friendly fashion in compliance with all local, state and national regulatory measures. Please minimize chemicals shipped to the competition site in order to reduce disposal costs.

6.1. On-Site Disposal. Teams are responsible to make each of their waste streams safe for disposal in one of the following available waste streams: Acid, Base, Organic, Aqueous,

Solid Waste. All team assembled items disposed in solid waste must be separated into their individual components with a neutral pH (pH 6-8) and contained in their own water tight container with a copy of their Team Waste Tag securely attached to the container.

6.2. Team Waste Tags. Team Waste Tags must be completed ahead of the competition based on anticipated waste streams and included at the end of the teams Engineering Design Package. Team Waste Tags must accompany all discharges of waste into AIChE waste containers and include at a minimum: Description of waste, Concentration, Volume, Team name, Table number.

6.3. Illegal Disposal. Failure to follow these rules on chemical handling may result in a safety incident being attributed to your team and possible suspension from future competitions. *See 28, Accidents/Incidents*.

7. Flames/smoke/noise. All cars are restricted from having any open flames or emitting any smoke. Cars shall not have internal flames. Any team that generates any open flame or smoke in the prep area or on the track will be disqualified.

7.1.1. Internal combustion engines (ICE). The only exception to this rule is that an internal flame is allowed in a commercial internal combustion engine (ICE) that uses an alternative fuel that is synthesized by students. Cars with ICEs are not allowed to produce smoke during the attempt. Succinct safety procedures for the maintenance and operation of this engine must be demonstrated by the team. In addition, cars with an ICE must show a demonstrable and significant student design component.

7.1.2. Noise. Noise from internal combustion engines must not exceed 90 db (as measured from a distance of 1 meter).

7.1.3. Gas Discharge. Gas discharge from an ICE shall be permitted when the exhaust has been properly filtered by a catalytic converter or other filter media to remove hazardous exhaust materials with including soot, obnoxious odor, and smoke.

7.1.4. Gas Discharge from a reaction: Any byproducts with an NFPA health rating of 3 or 4 must be scrubbed or removed prior to discharge.

8. ***Lasers****: Lasers direct a focused beam of energy on a target area and depending on the type and power may cause serious bodily harm and/or fire potential. Any lasers used in the design of a car require careful design and consideration in the design's hazard analysis.*

8.1. The use of IEC Type 3B and Type 4 lasers are not permitted to be used.

8.2. The maximum power output for any lasers used, regardless of color, shall be limited to 5 milliwatts maximum.

9. Solder: You cannot use solder containing lead in the manufacture or assembly of your car. There is to be no *planned* soldering at the competition. Soldering should be reserved for repair purposes only and minimized. All planned soldering should be done with adequate ventilation (ideally in a hood) at your home institution prior to the competition.

10. Liquid/Vapor/Odor Discharge. No liquid discharge, including water, is allowed. No obnoxious odor is allowed either through discharge or during use. All liquid products of reaction should be properly collected and contained within the vehicle, and properly disposed of (example, use of a scrubber/ holding tank). Discharge should only occur during emergency relief situations to protect the equipment from rupture and/or explosion.

10.1.1. Hydrogen Discharge. An exception to the 'no gas discharge' rule is that a small amount of hydrogen discharge is allowed. Students should provide calculations in the EDP to prove to the reviewer that any discharged hydrogen stream is diluted to below 1/4 of the LFL, as discussed in Section 1.1.10 of the Safety Rules.

10.1.2. Release of Pressurized Gas. Although pressure relief devices are required as a means of protection, the release of pressurized gas during the competition (greater than 5 psig [0.345 barg]) is not allowed. If a PRV functions during the attempt for any reason that attempt will be disqualified.

10.1.3. Gas Discharge Unpressurized, untreated gas discharge as a reaction byproduct is allowed without filtration for gases containing an NFPA health rating of 0, 1, or 2. (Example - water vapor, or CO_2 are OK, H_2S and SO_2 are NOT OK). The onsite safety personnel may disqualify any entry where the gas discharged by a vehicle is deemed improper. Disqualification due to excessive gas production is at the discretion of the observing safety committee, and the ruling is final and cannot be challenged

11. Reactive Materials. Teams using any chemicals with potential air/oxygen reactivity (e.g., flammable gases) **MUST** purge the system with an appropriate inert gas before the reactive gas is introduced into the system. The volume of inert gas used to purge the system must be at least three (3) times the volume of the system. Purging may be accomplished through the use of a small inert gas canister.

12. Open and/or Improperly Secured Containers. All containers on the vehicle containing chemicals (including water) must be securely attached to the vehicle to prevent the container from tipping over during the competition. The lid to this container must also be securely attached to the container and must be capable of preventing escape of the chemical during any phase of the competition, including an accident involving tipping over of the vehicle.

13. No Open containers, pipetting, or chemical pouring at the Starting Line or at the ready table. No open containers or manual pouring/pipetting of chemicals is permitted at the starting line or ready table. Built-in chemical reservoirs must be filled at the team's preparation table and securely attached to the car prior to moving to the ready table and starting line. Manual or automatic valves or switches can be used at the starting line. Violations will result in that run being disqualified. the built-in chemical reservoir is still subject to containment requirements, MOC compatibility, double containment, lid, etc., if necessitated based on the chemical(s) contained. All containers on the vehicle must have a secure lid and must be properly managed to prevent spillage.

13.1. Starting Line Procedure. All chemicals must be on the car and secured in fixed containment on the vehicle **before** walking to the starting line**.** Nothing may be carried away from the start line or left at the ready table**.** If any parts fall off the car either at the starting line or in competition will result in disqualification of that attempt. All containers, packets, etc. must be properly labeled and contained.

13.2. No Manually Plunged Syringes at the Starting Line or at the ready table. Teams cannot manually plunge a syringe at the starting line or the ready table. Manually plunged syringes cannot be included in the car design. This rule change is also to

promote better and safer design. Labeled syringes or pipettes can be used at the team's preparation table, but sharp needles are not permitted.

14. **No Sharp Needles.** Sharp needles cannot be used in any capacity (including, but not limited to in the operation and preparation of the vehicle) in Regional or Annual competitions.
15. **No Tied Balloons.** No pre-tied balloons are permitted in the competition space. This is primarily related to bringing balloons into the competition space containing lighter-than-air gases for reactions or purging. Mylar balloons floating to the ceiling are banned by most all ASC venues, as they have been known to trigger fire alarms in the past.
16. **No Specially Regulated Carcinogenic Chemicals.** A number of carcinogenic chemicals are listed by OSHA as a special carcinogenic hazard. The handling of these chemicals is outside the scope of the management systems available during the competition. Such chemicals are therefore not permitted. See www.osha.gov for details. These regulated chemicals include:

1,2-Dibromo-3-chloropropane	Beta-propiolactone
1,3-Butadiene	Bis-chloromethyl ether
2-Acetylaminofluorene	Chromium (VI)
3,3'-Dichlorobenzidine	Cadmium
4,4'-Methylenedianiline	Coal tar pitch volatiles
4-Aminodiphenyl	Ethylene oxide
4-Dimethylaminoazo-benezene	Ethyleneimine
4-Nitrobiphenyl	Formaldehyde
Acrylonitrile	Inorganic arsenic
Alpha-napthylamine	Methyl chloromethyl ether
Asbestos	Methylene chloride
Benzene	Methylenedianiline
Benzidine	N-nitrosodimethylamine
Beryllium	Respirable Crystalline Silica
Beta-naphthylamine	Vinyl chloride

17. **Disallowed Chemicals.** No chemical, raw material, intermediate or product that is highly reactive or unstable will be permitted. This includes chemicals with any of the following GHS hazard classifications: explosives, flammable liquids (Category 1), flammable solids (Category 1), self-reactive chemicals (Type A or B), pyrophoric solids, pyrophoric liquids, self-heating substances, substances which in contact with water emit flammable gases, oxidizing liquids (Category 1), oxidizing solids (Category 1), organic peroxides (Type A or B), acute toxicity (Category 1), and carcinogenicity (Category 1). This also includes any chemical on the extremely hazardous substances list published by EPA.

18. **No Liquid Hydrogen Peroxide Concentrations Greater than 30%.** Liquid hydrogen peroxide is very unstable and difficult to handle at concentrations greater than 30%.
19. **Acid Concentration Limits.** The risks associated with acids increase with higher concentrations. The maximum concentration allowed of commonly used acids are listed below. For acids not listed, please use the Chem-E-Car Questions form to check if your acid in your proposed concentration(s) is allowed. In general, if a fume hood is needed to dispense your acid, it is not permitted.

Acid	Maximum Concentration
Acetic Acid	10 M (50% vol)
Hydrochloric Acid	3M (10% vol)
Sulfuric Acid	5 M (30% vol)
Nitric Acid	Not permitted

20. Carbon Compound Restrictions. Dry primarily carbon containing compounds, such as carbon black, graphite, or activated carbon, in powder form are not allowed. You may ship wetted carbon compounds to the competition site following all DOT regulations and in conjunction with your university.

21. Pressure Restrictions. Pressurized vessels and vehicle components represent a significant explosion hazard due to the substantial energy contained in the pressure. The student team must also demonstrate that the proper safety systems have been installed to prevent an explosion.

21.1.1. The maximum allowable working pressure (MAWP) is the highest pressure the weakest component of your pressurized system can handle at a specified temperature. *Note that the MAWP for the 'car system' may be less than the MAWP the manufacturer listed for the pressure vessel. For example, the manufacturer of a pressure vessel may list the MAWP as 100 psig at 25°C, but if the vessel is connected to a piping system in which the weakest component has an MAWP of 50 psig at 25°C, then the MAWP of the overall system is 50 psig at 25°C (i.e., limited by the weakest component).*

21.1.2. The maximum operating pressure (MOP) may not exceed 90% of the MAWP of the overall pressurized system. No vehicle is permitted to have an MOP greater than 200 psig (13.8 barg) at any temperature (i.e., pressure systems on cars are not permitted to operate above 200 psig under any conditions). For initial design purposes, the MOP can be estimated from stoichiometry; however, the actual pressure must be measured once the car is operational. Student teams must demonstrate through appropriate pressure measurements that the pressures during normal operations do not exceed equipment specifications.

22. Pressure Gauge. All vessels and equipment with pressures greater than 5 psig (0.345 barg) must have a pressure gauge that reads from 0 gauge pressure to 2 times the MOP.

23. Emergency Relief Devices. All vehicles with pressures greater than 5 psig (0.345 barg) must have an industry-standard relief valve set at no more than 1.1 times the MOP of the vehicle.

23.1. Relief Device Testing. This valve must be tested and evidence must be provided in the safety documentation. If using a fixed set point PRV, the manufacturer specifications must be included in the EDP document. If using adjustable set point

PRV, proof that the PRV has been tested to that set point with a faculty member signature must be included in the EDP.

23.2. Sizing Calculations. All Emergency Relief Devices must be properly sized. Emergency relief system calculations must be included in the EDP documentation and they must be reviewed and approved by your faculty advisor. In addition, the following design specifications for the emergency relief device must be clearly stated in the EDP:

- Total quantity of reacting material assumed
- Concentration of the reactant(s) and
- Initial temperature

An example of pressure relief device sizing is included in the Chem-E-Car Safety Training Course. Additionally, an online copy of Crowl and Tipler's "Sizing Pressure-Relief Devices" is available in the Resources section below and may be used as a reference for sizing pressure relief devices. ***Note the important clarification below the resource hyperlink regarding a typo in the online copy.***

23.3. Emergency Relief Device in Proper Location. The relief device must be properly located. For vessels, the relief valve must be located at the top of the vessel without any valves between the vessel and the relief. Consideration must also be given for any entrained liquid or solids that might carry over from the vessel and prevent proper relief function. If a pressure reduction valve (pressure regulator) reduces pressure downstream to a value **above** atmospheric pressure, ALL piping and equipment downstream of the pressure reduction valve/regulator **must** be rated for that pressure or protected by an appropriate relief valve/frangible/rupture disk.

23.4. Piping. The piping connecting the relief to the vessel must be of appropriate size and must be as short as possible to prevent pressure drop during relief conditions.

Pressure Restrictions Example

A vehicle system has the following components.

- Reactor with MAWP = 1800 psi at 25°C
- Steel tubing with MAWP = 150 psig at 25°C

The MAWP of the Vehicle system = 150 psig at 25°C (weakest component in system)

MOP = 135 psig (90% of 150psig)

PRV maximum set point = 149 psig (1.1 x 135psig)

Appropriate pressure gauge range= 0 to 270 psig.(2 x MOP)

24. Pressure Testing. All components, including vessels, piping and fittings, valves, gauges, filters, must be certified to operate at a MAWP greater than your vehicle's MOP (and the MOP may not exceed 90% of the vehicle's MAWP). *For most components, the pressure specifications can be obtained directly from the manufacturer. This information must be provided with your engineering documentation package. For vessels, the pressure certification might not be known. In this case, you will need to either have someone test the vessel for you, or complete the pressure test yourself*

under the supervision of a faculty member. See Appendix A on Pressure Vessel Test Protocol and Procedure.

25. **Proper Management System to Prevent Over or Mis-Charging Pressure System.** Student teams must also be aware that the internal pressure in the vessel is dependent on the amount of reactant(s) charged. Students must demonstrate that proper management systems and controls are in place to ensure that the proper quantity of reactant is charged to the vehicle.

    25.1. Standard Operating Procedures. The following steps must be included in the Standard Operating Procedures of your vehicle to ensure proper charging:
    - **25.1.1.** The quantity to be charged should be agreed upon by all team members and must be supported by data obtained from operating the vehicle.
    - **25.1.2.** At least one team member should observe both the measuring and charging operation to ensure that it is done properly.
    - **25.1.3.** The car should be tagged once the charging is completed. This tag should remain until the attempt is finished.

26. **No Plastic in pressure service.** If plastics under pressure are used on the vehicle, the plastic must be certified by the manufacturer's data for the particular temperature, pressure, pressure at the operational temperature, and gas, or liquid being used in the plastic by the team. The manufacturer's data/datasheets must be available at all safety inspections to show to the inspector/EDP reviewer for verification.

    26.1. PVC rigid pipe. PVC plastic pipes, especially with glued or threaded fittings, are not allowed to be used under pressure. There are previous incidents that have occurred with this piping under pressure and thus, it is not allowed.

    26.2. Plastic tubing examples
    - **26.2.1.** A particular manufacturer-certified plastic tubing is rated to 200 psig (13.8 barg) at room temperature (25 ^{o}C) using compressed air. This tubing may not be used at a higher temperature (i.e.100 ^{o}C) unless the manufacturer has indicated that the tubing is certified to be used at 200 psig and 100^{o}C with compressed air.
    - **26.2.2.** If a plastic tubing is certified to be used for compressed air service at 100 psig and 25 ^{o}C, it may not be used with other gases; for instance CO_2, O_2, or other gases, unless the manufacturer certifies that the tubing is rated for these specific gases at these conditions.

27. **Chemical Containment**

    27.1. Primary Containment. The primary containment must be adequate to prevent leakage of any chemicals during normal transport of the vehicle to the starting line and during vehicle operation during the contest. The lid must be stout enough to provide no more than very limited release of chemicals during emergency conditions, such as a vehicle tip over or collision.
    - **27.1.1. Lids**. All lids on containers containing chemicals must be securely attached to the container and should cover the entire container opening. Please ensure that any holes in the lid or container are just big enough to accommodate the "through hole item" — seal if possible. Saran™ wrap, Parafilm™, aluminum foil and other similar materials are not adequate for use as container covers. However, caution must be exercised to ensure no pressure build up occurs in a vessel not rated for pressure.

    27.2. Secondary Containment. Secondary Containment is required for all liquids on the car. The secondary containment on the vehicle must be of suitable durability and size to hold the contents of any spilled chemicals on the vehicle. It is not required to have a lid for the second containment however it is good practice. *Proper measures must be taken during chemical*

handling in the vehicle preparation area to prevent human exposure to these chemicals – see Appendix B on Chemical Handling and Disposal.

28. Temperature Hazards. All exposed surfaces on your vehicle with temperatures greater than 150ºF (65.5ºC) or under 32ºF (0ºC) must either be insulated or covered to prevent contact with human skin.

29. Electrical Hazards

29.1. Preventing Electrical Shock or Ignition. All wiring and exposed electrical components must be insulated or covered to prevent the possibility of electrical shock or ignition of any component of a vehicle.

29.2. No Alligator Clips. Alligator clips and twisted wires represent both an electrical shock hazard and an ignition source for flammable vapors and/or liquids and are not allowed. Use more robust electrical connectors such as banana plugs or binding posts.

29.3. Charging Batteries. The charging of student-made batteries must be done in a safe way and documented within the EDP.

30. Mechanical Hazards Guards must be present for any moving parts and pinch points. This includes gears, belts, linkages, actuator arms and any other part that may present a pinch point.

31. Oxygen Service All components in oxygen service must be compatible with oxygen at elevated concentrations, which is defined as any atmosphere with an oxygen concentration greater than 20.9 volume percent. Reactions that generate oxygen (e.g., decomposition of hydrogen peroxide) will result in oxygen-enriched atmospheres. Components that must be compatible in oxygen service include vessels, piping, filters, regulators, valves, and electronic components. Metallic components are preferred because nonmetals are more susceptible to oxygen ignition. Electronic components, regulators, and/or lubricants for moving parts in oxygen service must be rated by the manufacturer for oxygen service and the rating/certification must be included in the EDP Supplemental. The equipment must not have been used previously for another chemical service that could leave residual ignitable material. In particular, gas regulators used for hydrocarbon gas service can ignite and potentially explode when placed into oxygen service.

31.1. Cleaning. All equipment in oxygen service must be thoroughly cleaned before being placed into service. Effective cleaning will: (1) remove particles, films, greases, oils, and other unwanted matter, (2) prevent loose scale, rust, dirt, mill scale, weld spatter, and weld flux deposited on moving and stationary parts from interfering with the component function and clogging flow passages, and (3) reduce the concentration of finely divided contaminants, which are more easily ignited than bulk material. Cleaning of the oxygen system must be done by disassembling all components to their individual parts. The cleaning procedure must be documented as part of the EDP Supplemental.

32. Biohazards If any biological organisms are used during any phase of the design, development, operation, competition and preparation of your Chem-E-Car, they must be no more than Level 1 biological hazards (also called biosafety level 1). This would include any bacterial, fungal, viral, or yeast organisms. *Proper handling procedures must be followed to minimize human exposure. All leftover cultures, stocks, and other regulated wastes must be collected, packaged and decontaminated according to local, state and federal regulations.*

33. **Accidents/Incidents.** If a safety incident occurs during the competition, the AICHE student chapter advisor of that team will be informed that an incident analysis report must be submitted to studentchapters@aiche.org. This safety incident report must be approved by the Chem-E-Car Competition® Student Chapters Subcommittee before any team from that university is allowed to compete in Regional or Annual Student Conference Chem-E-Car competitions.

34. **Competition Day Rules**
    - **34.1.** **PPE**: Each team must provide the appropriate personal protective equipment (PPE) for use in the chemical prep area, as identified in their JSA, and must use them properly. This includes lab coats, safety glasses, gloves, masks, face shields, and hearing protection. The personal protective equipment must be used appropriately by all team members depending on the hazards encountered during the chemical preparation.
    - **34.2.** **Electronics in prep area:** All portable personal electronic devices must be covered while in the prep area. Smaller portable personal electronic devices such as calculators and especially cell phones must be kept in clear plastic bags (e.g. Ziploc bags) throughout the competition. Teams will also be required to place screen covers and disposable keyboard covers over laptop and tablet touch screens and keyboards. The purpose of this rule is to prevent contamination of portable personal electronic devices. Teams are responsible for providing clear plastic bags, screen covers, and keyboard covers for their portable personal electronic devices. Failure to follow this rule will result in all team electronic devices being removed for the remainder of the competition from the prep area.
    - **34.3.** **Labeling Containers.** All containers with chemicals, including bottles, beakers, and plastic bags must be properly labeled. The label must minimally include the name of the chemical(s), and the name of the Chem-E Car team.
    - **34.4.** **Spill Containment at Table.** All chemical pouring or mixing in the preparation area must be done with spill containment. Your team must use a large tray compatible with your chemicals, with a volume large enough to hold your chemical quantities.
    - **34.5.** **Chemical Distribution.** All chemicals will be made available to the teams in the chemical preparation area at least two (2) hours prior to the performance competition. Absolutely no chemicals will be available for any team prior to three (3) hours before start of the competition. This includes battery-operated cars. Any requests to charge batteries overnight or longer than three (3) hours before the competition starts will not be granted.
    - **34.6.** **One Car in chemical prep area.** Each team is only permitted to have the car that passed the onsite safety inspection in the chemical prep area during the competition.
    - **34.7.** **Testing of vehicles in chemical prep area.** Teams can only test their reactions if the cars are held or supported on a stationary stand. The car wheels are not allowed to touch a solid surface (table or floor) under power.

35. **Requesting Assistance.** There is no restriction on requesting assistance for vehicle safety. Teams are encouraged to request additional safety assistance from their faculty advisor, other faculty members, other universities, other teams, and professional practitioners in industry and elsewhere.

Resources

National Fire Protection Association (NFPA). This method assigns a numerical value to the degree of hazard based on three major hazard groups: toxicity, flammability and instability/reactivity. The numerical values range from 0 to 4, with 0 representing the lowest degree of hazard and 4 representing the highest. See www.nfpa.org for more details on this.

National Institute for Occupational Safety and Health (NIOSH). An excellent source of information on the hazardous properties of chemicals. www.cdc.gov/niosh. In particular, they support a free, on-line guide to chemical hazards called the *NIOSH Pocket Guide to Chemical Hazards*. This is available at http://www.cdc.gov/niosh/npg/default.html.

Occupational Safety and Health Administration (OSHA) Information about Hazard Communication Standard (HDS), which is now aligned with the Globally Harmonized System of Classification and labeling of Chemical (GHS). Information on Safety Dara Sheets, & labeling can be found at https://www.osha.gov/dsg/hazcom/.

Information on GHS can be found at https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf

Crowl and Tipler, "Sizing Pressure-Relief Devices": https://www.aiche.org/sites/default/files/cep/20131068_r.pdf

NOTE: Equations (5) and (6) in Crowl and Tipler's "Sizing Pressure-Relief Devices" have a typo. The exponent (y+1)*(y-1) is incorrect, and instead should read (y+1)/(y-1)

SACHE module: *Emergency Relief system Design for Single and Two-Phase Flow*

AIChE Chem-E-Car Competition Safety Training Course: www.aiche.org/chemecar

Appendix A: Pressure Vessel Test Protocol and Procedure

The **test pressure** is the target pressure specified for the hydrotest. This specification depends on whether the MAWP of the vessel is known or not. See the Pressure Vessel Test Protocol shown below. The manufacturer recommendations for the use of all pressurized components, **especially plastic components**, for a vehicle must be thoroughly researched and documented. This includes following manufacturer's recommendations for use of materials.

No plastics such as: PVC, Tygon Tubing, cPVC, polyethylene terephthalate (PETE), ABS, PC, etc. are permitted for pressurized vessels or piping systems or for gases or liquids above manufacturer's temperature recommendations. All plastics have microscopic defects called crazes that grow into cracks as a result of hoop stresses, which can over time cause failure and therefore represent a hazard. NO exceptions to this rule will be allowed.

A.1 Pressure Vessel Test Protocol

There are three cases involving different protocols:

1. **You already know the MAWP of the vessel, and the vessel is less than 5 years old or has been retested within the last five years, and does not show any corrosion, wear or abuse**. In this case the vessel is already certified and all that is required is to obtain information related to this certification.

There are two ways to get this information:

i. The pressure vessel is already stamped with the MAWP or contains a plate indicating the MAWP. This indicates that it has been hydrostatically tested previously. Submit documentation that supports the MAWP rating, or a clear photograph of the name plate or the MAWP stamp and date of testing. See documentation requirements below.
ii. The manufacturer of the vessel supplies the pressure rating of the vessel via technical specifications. In this case provide copies of this specification. The age of the vessel must also be certified. See documentation requirements below.

The documentation is all that is required for the pressure certification for this case.

2. **You already know the MAWP of the vessel, and the vessel is more than 5 years old, or has not been retested within 5 years, or shows corrosion, wear or abuse.** There are two options available for this case:

   i. Use a commercial firm to recertify the MAWP via hydrotest. Provide documentation on this recertification with your JSA, including the name of the contractor and the date.
   ii. Recertify the vessel yourself using the hydrotesting procedure shown below. The test pressure in this case is 1.5 times the MAWP. See documentation requirements below.

3. **The MAWP is not known.** This case applies to unlabeled/undocumented vessels as well as custom-built pressure vessels. There is only one option available for this case:
   i. Use a commercial firm to certify the MAWP of the vessel and perform the hydrotest. Provide documentation on this certification with your JSA, including the name of the contractor. See documentation requirements below. Any vessel with an unknown MAWP (whether custom-built or not) must have its MAWP certified by a commercial firm or qualified university hydrotesting facility. Students are not permitted to self-certify the MAWP of such a vessel. There are no exceptions to this rule.

Appendix B: Chemical Handling and Disposal

B.1 Introduction

All ChemE car students who handle chemicals either at their host institution or at a regional or Annual Student Conference competition must understand the hazardous properties of these chemicals. Before using a specific chemical, safe handling methods must always be reviewed. Faculty advisers are responsible for ensuring that the equipment needed to work safely with chemicals is provided.

B.2 General Rules for Chemical Safety

A. Safety Data Sheets (SDS) must be available in the laboratory for all chemicals, including those in storage in the laboratory.

B. When purchasing chemicals, purchase the smallest quantity necessary to complete the planned experiments. The cost of disposal of unused chemicals far exceeds the savings from quantity purchases.

C. Skin contact with chemicals must be generally avoided.

D. No more than 2-gallons of flammable solvent should be out in the laboratory at any one time. Store bulk flammable containers in a flammable storage cabinet.

E. All containers (including those in storage) must be labeled – see the section on labeling below. Any unlabeled container must be treated as a hazardous substance.

F. Wear compatible gloves and apron when handling strong acids and bases.

G. Use a grounding strap and/or dip leg when transferring flammable chemicals into a storage tank.

H. Transport all chemicals using a safety carrier. The chemical must be in a closed container.

I. Chemical containers must be kept away from high temperatures, the edge of the lab bench, and other areas where an incident might lead to loss of containment.

J. Mouth suction for pipetting or starting a siphon is not allowed.

K. Unknown substances must be treated as toxic and flammable.

L. Do not taste or smell any chemicals.

M. Operations involving chemicals should generally be done in a laboratory hood.

B.3 Chemical Storage

A. SDS's must be available for all chemicals stored.

B. ALL chemicals stored must be properly labelled.

C. No chemicals shall be stored on the top of lab benches or out in the open. Chemicals must not be stored over eye level height to prevent accidents from dropping containers.

D. Flammable and volatile chemicals must be stored in a cabinet designated for flammable storage. See the discussion of flammable storage cabinets in the Safety Equipment section. Refrigerated storage of these chemicals requires a refrigerator rated for storing flammables.

E. Acids and bases should be stored separately.

F. Acid-resistant trays shall be placed under stored acid containers.

G. Acid-sensitive materials such as cyanides and sulfides must be separated from acids.

H. Oxidizable materials should be stored away from acids/bases and flammables.

I. Stored chemicals must be examined on a regular basis by the laboratory personnel (at least annually) to inspect for deterioration, container integrity, and expired dates. Chemicals which are not being used should be disposed of or returned to Chem Stores for recycling.

J. An inventory of stored chemicals must be maintained by the laboratory owner at all times. Leftover items shall be properly discarded or returned to Chemical Stores. Store only what you are using.

B.4 Chemical Labeling

All chemicals must be labeled, even during temporary transport. This includes lab samples, temporary containers, etc. A proper chemical label must include:

- Name, address and telephone number
- Product Identifier
- Signal word
- Hazard statement(s)
- Precautionary statements
- Pictograms

Pictograms are required on labels to alert users of the chemical hazards to which they may be exposed. Each pictogram consists of a symbol on a white background framed within a red border and represents a distinct hazard. Here are examples of pictograms you may encounter.

Health Hazard

- Carcinogen
- Mutagenicity
- Reproductive Toxicity
- Respiratory Sensitizer
- Target Organ Toxicity
- Aspiration Toxicity

Flame

- Flammables
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Self-Reactives
- Organic Peroxides

Exclamation Mark

- Irritant (skin and eye)
- Skin Sensitizer
- Acute Toxicity (harmful)
- Narcotic Effects
- Respiratory Tract Irritant
- Hazardous to Ozone Layer (Non-Mandatory

Gas Cylinder

- Gases Under Pressure

Corrosion

- Skin Corrosion/Burns
- Eye Damage
- Corrosive to Metals

Exploding Bomb

- Explosives
- Self-Reactives
- Organic Peroxides

Flame Over Circle

- Oxidizers

Environment (Non-Mandatory)

- Aquatic Toxicity

Skull and Crossbones

- Acute Toxicity (fatal or toxic)

B.5 Chemical Disposal

All chemicals must be disposed of in a safe and environmentally friendly manner. Any chemical substance which is corrosive, flammable, reactive, toxic, radioactive, infectious, phytotoxic, mutagenic, or acutely hazardous must be treated as hazardous waste. Do not dispose of chemicals by evaporation in a fume hood or in the sink! Do not hesitate if any questions occur about the hazards of a material.

Collect and store chemical waste in containers which are clearly labeled. Do not combine containers unless the contents in each container are known, compatible, and it is safe to do so. Combined wastes are much more difficult and costly to dispose of properly.

Ordinary waste such as paper, cardboard, etc., may be placed in the wastebasket. However, contaminated waste must be disposed of separately in a labeled container.

Empty chemical containers must also be disposed of in an acceptable fashion. They must first be cleaned and then either returned to Chemical Stores or disposed through normal trash.