WHAT IS REPLACEMENT IN KIND

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ABSTRACT

This document outlines the concept of "Replacement in Kind" (RIK) in the context of OSHA's Process Safety Management (PSM) regulations, emphasizing it as an efficient approach to Management of Change (MOC) by allowing certain replacements that meet original design specifications to bypass the formal MOC process. This approach is cost-effective as it avoids the extensive requirements typically associated with MOC, provided that the replacement aligns precisely with the original design intent, as outlined in OSHA's definition of RIK.

The document addresses challenges related to missing or incomplete design specifications, explaining three primary assumptions that guide RIK decisions in such cases: the "grandfathering" assumption, which allows identical part replacements; the "generic" assumption, which permits parts from alternative manufacturers if they meet the same operational criteria; and reliance on Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) where applicable.

Gateway Consulting Group, Inc.

8610 Transit Road, Suite 100, East Amherst, New York, 14051

www.gatewaygroup.com

INTRODUCTION

Replacement in Kind (RIK), when applicable, is the ultimate Management of Change (MOC), best practice. Qualifying for the RIK exemption eliminates the requirement to initiate an MOC project.

The Replacement in Kind Exemption

According to the PSM regulations "The employer shall establish and implement written procedures to manage changes (except for 'Replacements in Kind') to process chemicals, technology, equipment, and procedures; and changes to facilities that affect a covered process." [1, par. (l)]

What is Replacement in Kind?

OSHA provides the simple definition, "*Replacement in kind* means a replacement which satisfies the design specification." [1, par (b)].

Design Specification

The design specification began with the design intent for the process, and was initially expressed in the design documents that were created at the time the process unit was first designed. The design intent was expanded and detailed in the design calculations. The original design intent was provided by the process designers to the plant operator, historically, in the form of paper in binders. These were known by various names: design documents, data books, engineering data books, and sometimes even green books or blue books depending on the color of the binders. The design intent was further detailed in drawings and supporting documentation: P&ID's, PFD's, instrument lists, instrument spec sheets, etc.

No design activity has the bandwidth to define all the design standards, so industry standards are incorporated into the design specification by reference. Common examples include the ASME Boiler and Pressure Vessel Code, various ASTM material standards, ISA standards, etc. Additional engineering standards may also be incorporated by reference, whether they originate from the process designers or the plant operator.

Collectively, these items all constitute the design specification for a process. Furthermore, this could be considered the *original design specification*, since it existed at the time the process unit was designed.

There is no indication that procedures, whether for installation, operations or maintenance, are included in OSHA's definition for *design specification*, although procedures do play a role in RIK definition.

Design Specification Lifecycle

A process unit's configuration is not static—if it were, there would be no need for an MOC process. A process unit is constantly undergoing change from the following change agents:

- Management of Change instances
- Projects undertaken to enhance the unit, often called *capital projects* due to the way they are classified in the company's accounting system,
- Turnarounds: routine major maintenance activities, in theory, but in practice enhancements to the unit are always a part of turnarounds.

Any of these change agents may necessitate changes to the design specification. Also, periodic PHA revalidation may also cause changes to the design specification. Of course, in an operating plant, the change agents don't just act once: they can act many times as indicated by the feedback loop in Figure 1.

All the PSM elements contribute to safe operation of the plant, and up-to-date plant configuration information. So, if any qualification to OSHA's term *design specification* can be justified, it would have to be that OSHA intends the *current design specification* to be the correct source of the RIK definition.

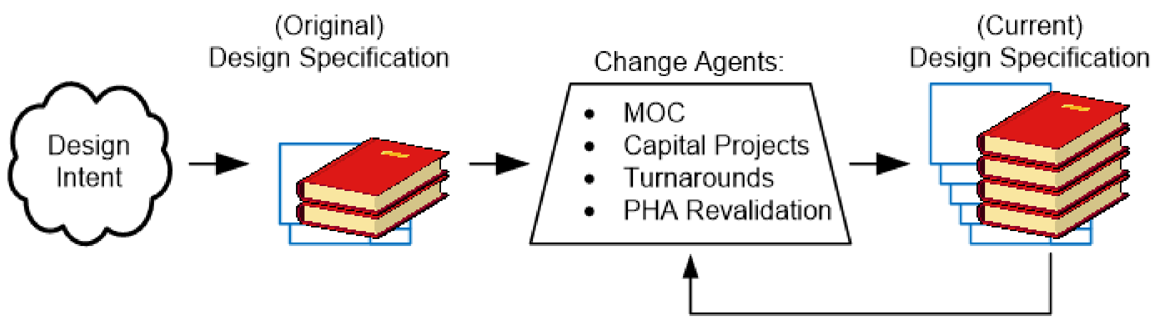

Figure 1. Design specification lifecycle

Broad or Narrow?

To achieve best practice, the creation of design specifications is a delicate balancing act. If the specifications are too broad, they may be inadequate and therefore unsafe: simply stating 3" pipe is far too broad, since the short- or long-term failure of pipe, under a given set of loads, depends on wall thickness, material properties, surface finish, exterior treatments, and so on.

To avoid the risks of specifications that are too broad, some designers over specify the design, thereby narrowing the choice of parts and suppliers. A common example is to specify a manufacturer or preferred supplier. The problem is that if the part is not available from the specified manufacturer/supplier, then the part in question is immediately not a replacement in kind. This raises costs, since an MOC is now required to qualify a part that would have been allowable if the design specifications were more broadly written.

At times it is necessary to specify the manufacturer, and/or preferred suppliers. This is particularly true with more complex parts. In some cases, the parts are so complex that the design specification is simply a copy of a vendor's documentation, the so-called Vendor Drawing or Source Control Drawing. These are certainly the proper practices for particularly complex parts.

However, the habit of using vendor-specific drawings should not be extended to simple, commodity items, since it may call for unneeded MOCs, as described above.

Identifying Replacement in Kind Based on the Design Specification

The design intent for the process unit was documented in the original design specification, which was formally updated, as needed, to yield the current design specification.

Extensions to the Design Specification

The current design specification is necessary but not sufficient to operate and maintain the plant. Additional documents (e.g. operating procedures) must be created to facilitate the day-to-day activities in the plant. Although these additional documents elaborate, extend or specialize the current design specification, they must at all times be consistent with the current design specification. As a result, activities which satisfy the requirements of these additional documents, logically and reasonably satisfy the requirements of the design specification. In other words, if a proposed change satisfies the requirements of the additional documents, then the proposed change is a replacement in kind.

Common extensions to the design specification, illustrated in Figure 2, include:

1. Operating envelopes: the operating envelope is the set of all combinations of parameters (e.g. temperature, pressure, flow) within which the equipment is certified to operate. When the operating point (i.e. a specific value of temperature, pressure, flow, etc.) is changed to a different operating point (i.e. a different specific value of temperature, pressure, flow, etc.) but still within the operating envelope, then such a change is considered a replacement in kind.
2. Written procedures and business processes for operations: Any proposed change that is already documented in operating procedures, or related documents, is considered a replacement in kind.
3. Written procedures and business processes for maintenance and repair: Any proposed change that is already documented in maintenance, repair or other procedures, or related documents, is considered a replacement in kind.
4. Written training and qualification requirements: Any proposed change that is already documented as training requirements or people's qualifications for certain tasks is considered a replacement in kind.
5. Schedules or schedule requirements: Any proposed change, that is within the bounds of an already documented schedule (e.g. March 23rd) or in schedule requirements (e.g. *once each year*), is considered a replacement in kind.

If a proposed change does not meet the requirements of any of these 5 design specification extensions, then the proposed change is not a replacement in kind.

Missing or Unavailable Design Specifications

A part failure in the plant calls for action. Most people can determine when a part, say a pump, is not working. However, not everyone can determine what the design specification for the pump is, how it's documented, where those documents are stored, and once retrieved, whether those documents are complete or even correct. Even in the absence of convenient access to the current design specification, and even without complete trust in any documented design specification, decisions still need to be made about whether a proposed change qualifies as a RIK. These decisions are made daily, and they tend to be justified based on 3 different assumptions:

1. Grandfathering assumption: All equipment, and other process safety information (e.g. procedures) are assumed to be in compliance with the current design specifications. After all, prior to installing the equipment, or adopting the procedures, *someone* had to qualify it as being safe. In other words, all the existing equipment is *grandfathered* into the category of items which satisfy the design specification. Consequently, if a failed part is replaced with an identical part, then the replacement is considered in kind.
2. Generic assumption: This is an extension of the grandfathering assumption. This assumes that the design specification is not vendor specific. Therefore, failed parts can be replaced with parts from different manufacturers, provided that the physical, operational and maintenance parameters of the replacement part are the same as those of the failed part.
3. Based on RAGAGEP and with no PSI impact: There is value in Recognized and Generally Accepted Good Engineering Practices, since this how the design specifications (original and current) were created in the first place. Neither the design specification nor the process safety information contains all details of all parts. When new situations arise (should we order a green one or a blue one?) which have no safety impact, and do not change the process safety information, then a properly qualified person may accept the item as a replacement in kind.

Lists of Replacement in Kind Examples

When a person encounters a potential Replacement in Kind situation, it would be helpful to have a list that indicates what is and isn't an RIK in that circumstance. The more specific the RIK example, the more useful it is to the end user. For instance, information like *ACME X100 valves can always be replaced by ACME X101Z valves* would be helpful. However, a corollary to that statement is, *the ACME X101Z valve satisfies the design specifications of the ACME X100 in all cases where the X100 is currently used*. It may be true that the X101Z satisfies the X100 design specifications in some cases. But, in all cases, everywhere? If there's one situation, somewhere, where the X101Z is not a replacement for the X100, then the X101Z isn't *always* a replacement for the X100.

So, attempting to come up with a universal RIK list, at this level of detail, isn't practical since this list would be empty. However, it is possible to develop a site-specific RIK list at this level of detail, since a given part, like the X100, is only used in a few dozen contexts and those could all be analyzed beforehand.

Various authors [2-5] have provided lists of RIK examples. These examples are more general and are intended to be universal. All these published universal RIK examples are presented in Figure 2.

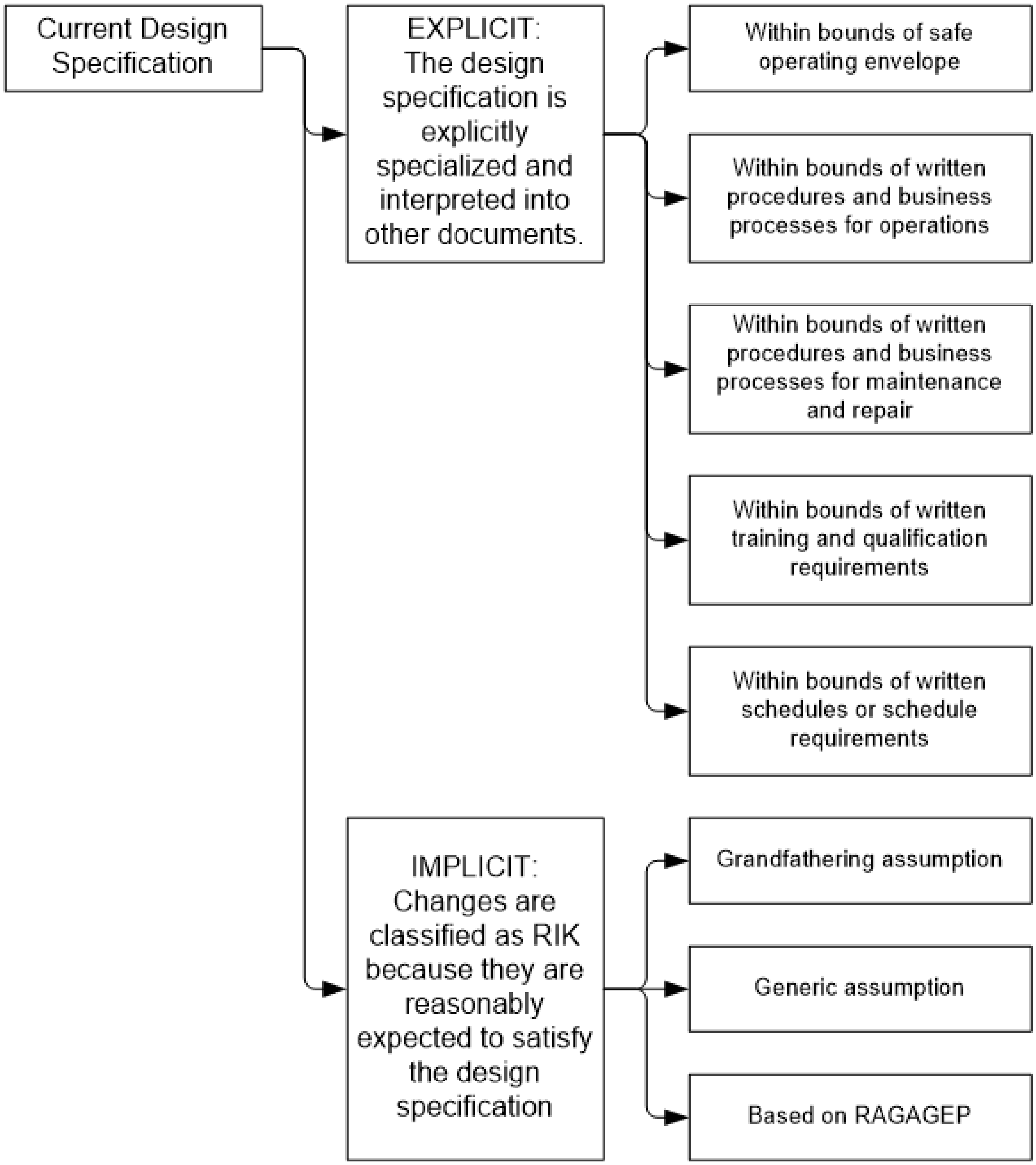

Figure 2. How different replacements in kind relate to the design specification.

	RIK Justification	Example
EXPLICIT: The design specification is explicitly specialized and interpreted into other documents.	Within bounds of safe operating envelope	Raising a reactor operating temperature within a safe operating envelope♦
		Raising the maximum storage tank level within the safe operating envelope for that tank♦
		Resetting the trip point on an interlock, but staying within the safe operating range established by prior safety analyses
		Turning a controller to more tightly control the process variable
		Modifying process operating parameters but staying within the safe operating range established by prior safety analyses; including, but not limited to: • Flow • Temperature • Pressure • …
		Adhering to process flow paths previously assessed by PHAs or other safety evaluations
	Within bounds of written procedures and business processes for operations	Modifying the packaging of raw materials, intermediates, or products, where the new packaging satisfies the requirements established for the safe handling of the subject material (e.g., substituting a plastic drum for a stainless-steel drum for a corrosive solution when the only requirement is for the use of a corrosion-resistant container).
		Rearranging warehouse stock, but within the established basis for safe operation with respect to consideration such as: • Inventory limits • Compatibility groupings • Fire protection system capabilities
		Delegating authorization responsibilities (e.g. for work order approval) to a properly qualified substitute in accordance with the pre-established delegation schedule
		Operating a process with an interlock out for maintenance but with alternative means of protection provided, as specified in the operating procedures
		Rigidly enforcing the requirement that face-to-face shift turnovers be conducted at the job site

	RIK Justification	Example
EXPLICIT: The design specification is explicitly specialized and interpreted into other documents.	Within bounds of written procedures and business processes for operations	Communicating with the intent to clarify or reinforce existing policies (without modifying such policies)
		Rigidly enforcing existing safe work practice procedures
	Within bounds of written procedures and business processes for maintenance and repair	Repairing a corroded vessel to restore its original wall thickness
		Making a piping system repair in a fashion that conforms exactly to the original design specification
		Rigidly enforcing existing safe work practice procedures
		Relocating hot work to another area within a nonrestricted ("free burn") hot work site
	Within bounds of written training and qualification requirements	Promoting a properly qualified operator to a lead operator♦
		Reassigning inspection, testing, and preventive maintenance tasks to comparably qualified personnel within the same work group
		Reassigning emergency response roles among equally capable personnel
		Replacing an employee with a comparably qualified employee (or providing a suitable overlap between the incoming and outgoing employees to allow the new employee to gain the needed qualifications)
		Reassigning personnel from one shift team to another while maintaining the same basic staffing structure.
		Replacing the current maintenance contractor with another qualified contractor
		Promoting a properly qualified operator to chief operator
		Rigidly enforcing existing safe work practice procedures
		Rotating the responsibility for facilitating incident investigations among a group of comparably qualified leaders

	RIK Justification	Example
EXPLICIT	Within bounds of written schedules or schedule requirements	Sampling a process stream on Mondays and Thursdays instead of Tuesdays and Fridays (assuming that other related activities are constant throughout the week)
		Scheduling process outages as required to provide access to safety systems for inspection, testing, and preventive maintenance
		Changing from a spring turnaround to a fall turnaround within the run-time limit for the unit.
		Decreasing the test interval for a high temperature interlock
		Changing the day of the week on which operators are scheduled to attend refresher training on operating procedures (assuming that this does not disadvantage any particular shift)
IMPLICIT: Changes are classified as RIK because they are reasonably expected to satisfy the design specification	Grandfathering assumption	All identical replacements✯
		Replacing vessels or piping with equipment having the same dimensions, configuration, metallurgy, wall thickness, pressure and vacuum rating, design temperature, heat treatment, etc.
		Replacing a valve with one that is, in all respects, identical to the original
		Replacing a DCS system component with an identical replacement (e.g., a module that receives field inputs and converts the analog signal to a digital signal for use within the DCS)
		Replacing an instrument with an identical spare
		Recharging a fixed fire protection system with the same firefighting agent previously used
		Replacing an explosion relief vent panel with an identical unit from the same manufacturer
		Repaving an existing road while maintaining existing drainage, shoulder elevation, width, etc.
	Generic assumption	Replacement of a vessel or piping with equipment of the same size, metallurgy, wall thickness, pressure rating, and design temperature♦
		Acceptance of a shipment of inbound refrigerant-grade anhydrous ammonia from an alternate supplier⌘

	RIK Justification	Example
IMPLICIIT: Changes are classified as RIK because they are reasonably expected to satisfy the design specification	Generic assumption	Replacing rotating equipment with new equipment of the same material, capacity, flange rating, seal design, driver type, horsepower, etc.
		Using alternative vendors as sources of feed stock that meets all established purchase specifications
		Changing to another brand of lubricant that meets the specifications established for the service required
		Replacing process area lighting with fixtures of the same type and design
		Replacing weathered siding on the chemicals warehouse using the same materials of construction
	Based on RAGAGEP and with no PSI impact	Minor piping rerouting ☼
		Making minor editorial changes or typographical corrections to operating or maintenance procedures
		Using OEM manual maintenance procedures
		Providing a new building or relocating personnel within existing buildings when the buildings are beyond the consequence zone for process incidents (vapor cloud explosions, toxic releases, etc.)
		Formalizing the currently implemented, but not yet documented, practices for field safety inspections of contractor activities

LEGEND:

⌘	From ref. [2]
♦	From ref. [3]
☼	From ref. [4]
✯	No reference
Unmarked	From ref. [5]

Table 1. Replacement in kind examples, with relevant justification.

Issues in Deciding When Something is Replacement in Kind

So far, OSHA's concept of "…satisfies the design specification" appears simple enough. We've added the rather obvious qualification that the design specification be the correct one, which means that it has to be current. We've also explained that vendor-specific information is sometimes provided as a means of dealing with very complex parts.

Synonyms

Most company's MOC procedures correctly identify that the formal MOC procedure does not need to be followed, if the change is an RIK. The procedures then attempt to explain what an RIK is, often using one or more of the following synonyms:

1. functionally identical
2. equivalent
3. like-for-like
4. generic equivalent
5. improvement
6. minor change
7. meets original design specification
8. conforms to baseline data
9. conforms to design basis
10. meets System Requirement Specification

List items 1, 2 and 3 are not explicitly wrong, and they may contribute to the layperson's understanding of RIK. But it must be remembered that these are layperson's terms for the regulatory wording *satisfies the design specification*. Taking the elaboration one step further and explaining what *equivalent* means, takes the discussion further from the (regulatory) requirement.

Item 4 sounds like a reasonable idea, and when a generic part is permitted, it should be stated in the design specification.

Item 5 is a change. It's not RIK, as explained in a subsequent section.

Item 6 is a change. It's generally not RIK. The only exception would be if it can be determined to have no possible impact on safety and not require any process safety information updates. That assessment would have to be done using RAGAGEP.

Items 7 and 8 may or may not be valid. As indicated in Figure 1, the original design specification, or design basis as some call it, evolves over time, so the original may be out of date.

Items 9 and 10 are valid RIKs. Item 9 is simply a replacement of OSHA's "satisfies" with *conforms*. Item 10 is valid, but normally used for Safety Instrumented Systems, which normally have a System Requirements Specification.

The synonyms contribute only a little to understanding and may be wrong. Perhaps written procedures should emphasize the "satisfies design specification" term as much as possible.

On-site Repairs and Refurbishment

Equipment that's taken out of service, due to failure, turnarounds or routine maintenance, often arrives at the maintenance shop. These parts are commonly repaired or refurbished, using the collection of maintenance procedures that form the site's mechanical integrity program. When this work is complete, the parts are often entered into inventory awaiting redeployment elsewhere in the plant.

In essence, the mechanical integrity program has certified that the repaired or refurbished parts can now be a RIK candidate, as shown in stream ① of Figure 3. The refurbished part is merely an RIK candidate, since, for example, an X100 valve is an RIK candidate for other X100 valves (and perhaps a few cases of non-X100 valves, depending on the design specifications), but it's obviously not an RIK candidate for all valves in the plant.

Class vs. Instance Distinction

Sutton [6] makes the interesting observation, "all changes, when analyzed deeply enough, are not in-kind." True enough, the molecules of the replacement part are not the same molecules as are in the original part, and they may actually behave differently in service. Nonetheless the regulations define RIK as "satisfies the design specification" and design specifications specify a *class* of items, not *instances* of items. That is, the design specifications describe, say, an *ACME X100 valve*, so any (new!) ACME X100 valve satisfies the specification. The specifications don't state "ACME X100 valve with serial number 563,349", which describes a specific instance of the X100 valves, but is clearly too narrow for specification purposes.

So, replacing an ACME X100 valve with another (new) ACME X100 valve, is permitted, and is exactly what the replacement in kind concept is all about. A new X100 valve is immediately considered an RIK candidate, as shown in stream ② of Figure 3.

Replacement Parts of Uncertain Provenance or Condition

In the previous paragraphs, the qualifier *new* was used to describe the replacement part. Baker [7] has written extensively about the potential dangers of procuring anything other than new parts from reputable suppliers.

Used parts may have been subjected to harsh environments, suffered corrosion, erosion, over-voltage or over-current conditions, excessive temperatures or pressure, etc. Consequently, they may be more failure-prone and the failure modes may be unexpected (e.g. collapse due to stress-corrosion cracking). Most importantly, they do not satisfy the design specifications, critical to their acceptance as an RIK.

Less expensive parts are available in the secondary market with labels like "new-surplus" or "reconditioned". The vendors of these parts often make very reassuring claims, like:

- "meets or exceeds factory specifications"
- "meets and even exceeds OEM testing standards"
- "remanufactured to 'like new'"
- "fully reconditioned to OEM specifications"
- "remanufactured to original manufacturers' specifications and tolerances".

The concern is that most of the vendors of second-hand parts do not have the facilities to guarantee that the remanufactured parts actually meet all the original specifications. Some of the vendors don't even have access to all the original specifications. Baker indicates that this is particularly problematic with instrumentation, where end-user inspection of the used parts isn't as simple as inspection of, say, the wall thickness of valves.

Even *new-surplus* parts are in question, since they may have been (improperly) installed, thereby inducing hidden defects, although to the purchaser they still appear to be new.

So, any part that is not new or acquired from someone other than a manufacturer-approved supplier, would not be considered an RIK candidate, as shown in stream ④.

For an externally sourced part, whether refurbished or surplus, to become a RIK candidate, it must be evaluated according to relevant inspection and maintenance procedures, as shown in stream ③. Admittedly, this shifts the burden of RIK determination from the MOC owner to the Inspection Department. But this is the correct approach and may be more economical than flatly refusing to consider any refurbished or surplus part.

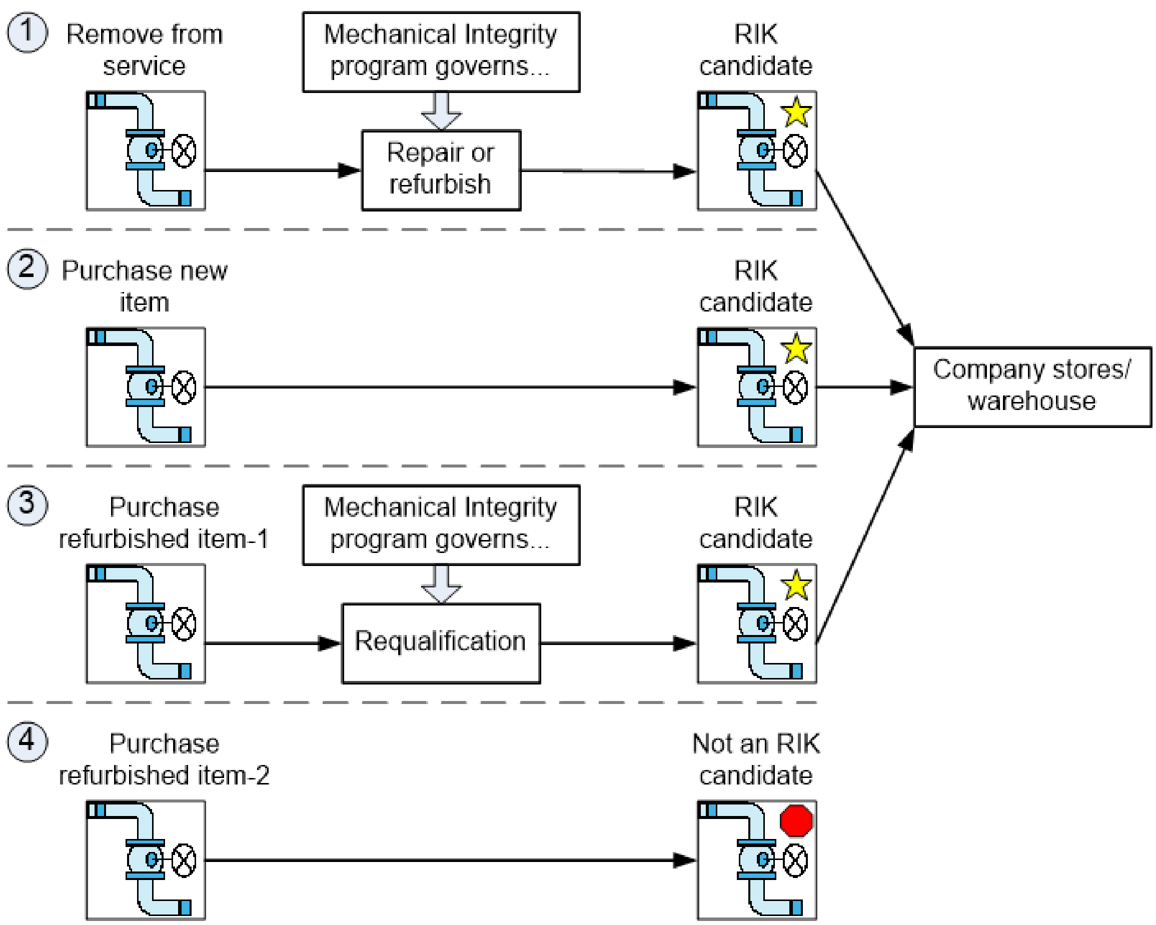

Figure 3. Source-dependent RIK classification

Apparent RIK Necessitating a Procedure Change

Design specifications usually do not contain information like:

- installation procedures
- maintenance procedures and recommended intervals
- inspection procedures and recommended intervals

This information is normally provided by the part vendor and then adopted and incorporated into company procedures. We have called these *extensions* to the design specification.

A part from a different vendor may satisfy the design specifications (classifying it as an RIK), but if it has different installation, maintenance and inspection particulars, than the original part, then an MOC will be required anyway, since procedure changes always trigger MOCs.

Improvements are not Replacement in Kind

There is a tendency to interpret the notion of *satisfies the design specification* to mean *satisfies the design specification, or better*. Of course, unless *better* is defined in the design specification for the part, then *better* is almost always a change, and therefore not an RIK.

Examples abound, where something that appears to be better causes unexpected consequences:

1. Reducing the set point of a pressure relief valve by 5%, appears to be *better*, but this reduces the relieving capacity, which in turn requires a larger relief valve orifice.
2. Replacing existing gaskets with the more corrosion resistant Teflon™ gaskets. But Teflon™ may creep more than the original material, and cause leakage.

References

[1] U.S. Dept. of Labor, 29CFR1910.119, *Process Safety Management of Highly Hazardous Chemicals*.

[2] Reindl, D.T, Management of Change Presentation, University of Wisconsin.

[3] Sanders, R.E., *Chemical Process Safety, 3rd Ed., Learning from Case Histories*, Gulf Publishing, 2004.

[4] U.S. Environmental Protection Agency, *Chapter 7: Prevention Program*

[5] CCPS, *Guidelines for the Management of Change for Process Safety*, Wiley-AIChE, 2008.

[6] Sutton, I., *Management of Change (MOC) in the Process Industries*

[7] Baker, R., *Hydrocarbon Processing*, Process safety concerns can arise when using refurbished or new-surplus equipment, Nov. 2006, pp.73-80.