20

Decommissioning Phase
An Illustration of the What-If/Checklist Analysis Method

20.1 Problem Definition

Background

ABC Chemicals, Inc. has been producing VCM for over 30 years. Their expansion into the VCM market proved quite profitable; in addition to the Anywhere plant, ABC has built VCM manufacturing facilities at three other locations. However, the Anywhere VCM plant has become less efficient as it has aged, and ABC has decided to reduce production at the plant in an effort to cut costs; the newer and more efficient plants will increase their VCM production.

As part of the reduction in capacity, ABC will decommission one of the plant's four furnaces used to crack EDC and make VCM. (This furnace was scheduled to have its tube bundle tested at the next turnaround.) Prior to decommissioning, the Anywhere plant manager has asked that a hazard evaluation of the decommissioning plan be performed.

No personnel at the Anywhere plant have performed or participated in an HE study involving the decommissioning of a process. Thus, the plant manager asks ABC's process hazards analysis group for assistance. Mr. Dennis, the director of the group, assigns Mr. O. L. Timer to this project. Mr. Timer has performed numerous hazard reviews, including HE studies of equipment being decommissioned. Through his experience, and the experience of others in ABC's process hazards analysis group, he has developed a checklist (Table 20.1) for reviewing decommissioning activities. Mr. Timer tentatively plans to use this checklist for the HE study of the furnace decommissioning activity.

Available Resources

ABC is considered by the industry to be a leader in VCM production. As a result of their vast experience, ABC has substantial information on the design and operation of VCM plants, including P&IDs and design specifications for the cracking

Table 20.1 Sample Decommissioning Checklist

Shutdown and Isolation

1. Do procedures exist for shutting down the unit? Are personnel familiar with these procedures? Has the unit been shut down before? Is operations aware of the decommissioning?
2. Do decommissioning procedures exist? Have they been reviewed for technical content?
3. Have equipment changes or modifications occurred that are not reflected in the system documentation? Have the potential effects of these changes on maintenance actions been addressed?
4. Will utility systems be disconnected from the unit? Do appropriate lockout/tagout procedures exist? Are the disconnections permanent? Will making these disconnections affect other units?
5. Will any safety or control feature be temporarily or permanently disabled? How will this affect other operating equipment? Will it possibly initiate a shutdown?
6. Will someone familiar with the decommissioning plans always be available for emergencies? Do emergency plans exist?
7. Is any special medical surveillance required during decommissioning?
8. Are any fire protection systems being disabled as part of decommissioning?
9. Will equipment always be electrically grounded?
10. How will the unit process lines be isolated from other plant systems? Will someone verify these isolations?
11. Do all isolated vessels have adequate relief protection? Are relief paths clear and operable during decommissioning?
12. Do any vessels require vacuum protection during decommissioning? Will any isolated vessels be cooled during decommissioning?

Draining

1. Do procedures exist for draining process material from the unit?
2. Is any special protective gear needed during draining operations?
3. Will lines have to be "broken" to drain the unit? Do adequate measures exist to ensure that very hot, very cold, or high pressure material is not in the line? Do adequate measures exist to protect against toxic or flammable releases? Are hot work permits or line break permits required?
4. How will the drained material be disposed of? Will this vessel contain incompatible materials?

Table 20.1 (cont'd)

Draining (cont'd)

5. Does the area have proper ventilation should a spill occur? Does it have proper drainage? Does it have adequate fire protection?
6. Will access to the area be limited during draining activities?
7. Is the area free of ignition sources? Is the area free of combustible materials?
8. Is the equipment used to drain the unit compatible with this process material?
9. Will confined space entry be required to drain the unit? Have permits been obtained?
10. Are reverse flows possible in the drain line?

Cleaning

1. Will the equipment in the unit be cleaned after draining?
2. Are the cleaning materials potentially reactive with any process materials? Can less hazardous materials be used?
3. Do the cleaning materials require special handling? Is personal protective equipment required?
4. Could the wrong cleaning material inadvertently be used?
5. How will the cleaning solution be disposed of?
6. If the cleaning material is combustible, have appropriate fire protection measures been taken?
7. Are there any concerns with residues left after cleaning?

Dismantling

1. Will heavy equipment be used to dismantle the unit? Are adequate measures in place to monitor heavy equipment movement? Are rigging checks required? Is the lighting adequate?
2. Are there hazardous or flammable materials in the area that could be released in an accident? Are adequate safety precautions in place?
3. Will equipment in the unit be reused? Is it adequately designed for the new service?
4. Is the equipment properly labeled?
5. Where will the equipment be stored? Are there any special storage requirements?
6. Are any special procedures needed to comply with environmental regulations?
7. Are there other units, lines, etc., in areas that may be hit by heavy equipment used for the dismantling?

furnace that is being decommissioned at the Anywhere plant. In particular, the Anywhere plant has the following information available for the HE study:

- Furnace piping and instrumentation diagrams
- Furnace design specifications
- Process flow diagrams (Figure 20.1)
- Operating procedures and logs
- Maintenance procedures and logs
- Incident histories
- Previous HE studies
- MSDSs for all VCM plant process materials
- Plot plans
- Environmental regulations

Anywhere plant personnel have developed a preliminary plan for decommissioning the furnace. This information, supplemented with the knowledge of highly experienced Anywhere plant personnel, will be used in the HE study of the furnace decommissioning.

Selection of Hazard Evaluation Technique

Decommissioning the furnace could expose personnel to many different hazards. For this reason, Mr. Timer decides to use an HE technique that examines a broad range of hazards. Thus, he quickly narrows his choice to PHA, What-If Analysis, Checklist Analysis, HAZOP Analysis, and FMEA. Since the furnace is not operating during the decommissioning, the HAZOP Analysis and FMEA techniques are not strong candidates. Of the remaining three methods, Mr. Timer selects the Checklist Analysis method because (1) the Checklist Analysis method covers a broad range of hazards, (2) he has a decommissioning checklist that he has successfully used in the past, and (3) the Checklist Analysis method can be used quickly and easily.

However, Mr. Timer has never performed a Checklist Analysis of VCM equipment being decommissioned. For this reason, he decides to supplement the Checklist Analysis with a What-If Analysis. To do this, Mr. Timer encourages the review team to ask any What-If questions as they move through his checklist. Mr. Timer has performed a What-If/Checklist Analysis in the past both by (1) examining the items on a checklist and then asking What-If questions and by (2) asking What-If questions as he examines items on a checklist. He prefers the latter method, so he uses it in this study. Mr. Timer hopes the checklist items will prompt team members to ask questions that reveal potentially hazardous situations.

Study Preparation

To perform the What-If/Checklist Analysis, Mr. Timer needs skilled personnel familiar with the planned decommissioning activities. Because the government has placed increasingly complex and stringent environmental regulations on EDC and VCM over the years, Mr. Timer decides that an environmentalist should also participate in the review. The following skilled personnel are selected for the review:

Leader	—	A person skilled in leading What-If/Checklist Analysis. Mr. O. L. Timer will be the leader.

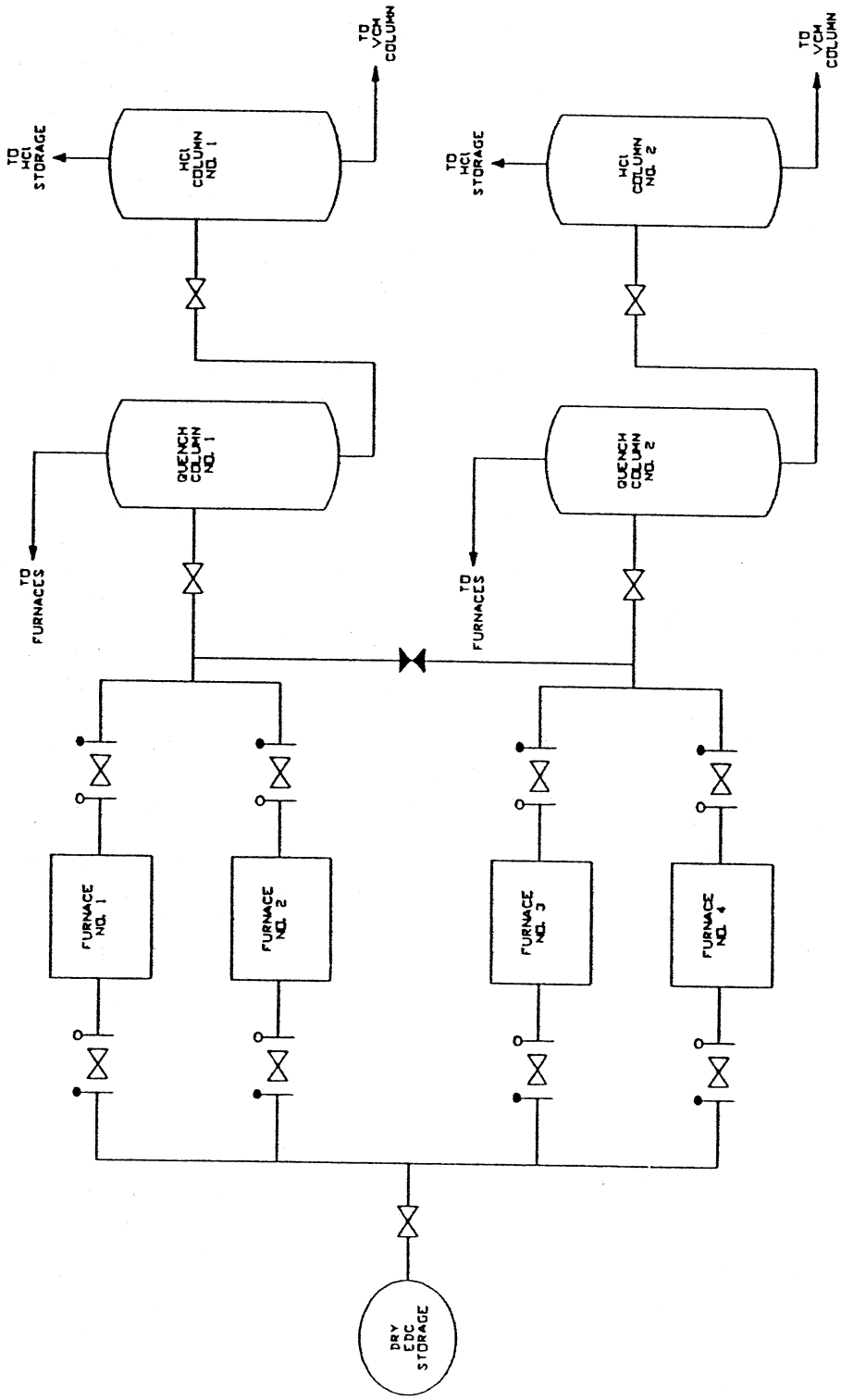

Figure 20.1 Process flow diagram for VCM furnace area.

Process Engineer	—	A person thoroughly familiar with the operation of the VCM plant, and, in particular, the operation of the furnace area. Mr. C. Chem, the process engineer for the furnace area and an author of the decommissioning plan, will fill this position.
Maintenance Engineer	—	A person who knows plant maintenance practices for the furnace area. Mr. P. I. Fitter, the maintenance engineer who helped develop the decommissioning plan, will serve in this role.
Environmental Specialist	—	A person knowledgeable of the environmental regulations regarding EDC and VCM. Ms. Kelly Green, the environmental engineer for the Anywhere plant, will fill this position.

To prepare for the HE study, Mr. Timer reviews the information on the furnace. In particular, he focuses on the decommissioning plan, the plot plan (since heavy equipment will be needed to dismantle the furnace), and the P&ID (which shows how the furnace interfaces with other plant equipment). He then prepares an information package to send to each team member. This package contains appropriate drawings of the furnace area, the decommissioning plan, and Mr. Timer's checklist. Mr. Timer also includes in this package a description of the Checklist and What-If Analysis methods.

A one-day What-If/Checklist Analysis is planned. Mr. Timer schedules the review at the Anywhere site so that the team can inspect the furnace area before the review. Choosing this location also enables the team to readily obtain additional information and personnel if needed for the HE study.

As a final note to the team members, Mr. Timer asks them to prepare some What-If questions before the review. He knows that the team discussions will prompt other ideas and concerns; however, he has found that if the team members do some homework before the meeting, the results of the HE study are generally better and the members are more prepared to answer questions as the review progresses.

20.2 Analysis Description

The What-If/Checklist Analysis begins at 9:00 a.m. with a brief tour of the furnace area at the Anywhere plant. During this tour Mr. Chem and Mr. Fitter describe how the furnace will be isolated from the rest of the plant, emptied, and dismantled. Following this tour the team reconvenes in the plant's training room to begin the study. Before starting through the checklist, Mr. Timer reviews the ground rules for the discussions. They are: (1) all team members have a right and responsibility to raise any issue that concerns them, (2) no issue is unimportant, (3) the aim is to identify safety concerns — not solve them, (4) criticism of team members is not allowed, and (5) all team members are equals. With the ground rules established, Mr. Timer opens the discussions.

Mr. Timer — As I stated in the memo to each of you, we will perform a What-If/Checklist Analysis of the decommissioning for the No. 4 furnace. To do this, we will discuss each of the items on the checklist I sent you (*Table 20.1, provided prior to this narrative*). However, the discussions are not limited to just the items on the checklist. I hope the checklist will prompt other What-If questions. I will make note on the chart pad of any important issues that arise so that you can keep me honest. Mr. Chem has also agreed to take notes as a backup. Any questions before we begin?

Ms. Green — I didn't have a chance to review the written decommissioning plans. Think we could have a brief overview before starting?

Mr. Chem — I can do that, Kelly. As you know, we are taking the No. 4 furnace out of service as part of the plant's reduction in capacity. To do so, we'll first shut down the furnace. This will be done in three steps: first, the inside operator will shut off fuel gas flow to the furnace; then, the outside operator will block in the gas supply to the furnace; and then the outside operator will block in the furnace process supply line. We've shut down the furnace this way many times. Then we'll blow the tube bundle clear with nitrogen and block in the process discharge line from the furnace. Once the furnace is cool, we'll open it up and remove the tube bundle. For this, of course, we've got to use a crane. The tube bundle will be taken to the maintenance shop for cleaning, and then will be shipped to the Somewhere plant for reuse. The rest of the furnace will be mothballed for now.

Ms. Green — [*Nods.*] Thanks for the overview.

Mr. Timer — Let's move on to the checklist. Do you have shutdown procedures for the furnace, and are the operators familiar with them?

Mr. Fitter — Yes and yes. As Mr. Chem just said, operations has shut down this furnace many times in the past.

Mr. Timer — I see my next checklist item is already answered, then. How about the decommissioning plans. Have the operators discussed these plans?

Mr. Chem — Both P. I. and I have talked with the operators about decommissioning and considered their input in drafting the plan; however, they haven't yet reviewed it.

Ms. Green — Has anyone reviewed the plan?

Mr. Fitter — Just this group.

Mr. Timer — I recommend that you have this plan reviewed by the unit supervisor, the area maintenance manager, and the plant safety coordinator. [*Mr. Timer writes this recommendation on the flip chart for the group.*]

Mr. Fitter — Okay.

Mr. Timer — The next item on the list is equipment changes. Have you modified the furnace so that it might change your shutdown procedures or decommissioning plans?

Mr. Chem — The furnace hasn't been modified in over 10 years. And we have gone through several shutdowns without a hitch during that time.

Mr. Timer — Okay. Let's move over to the utilities for the furnace. Will they be disconnected permanently? And will these disconnections affect other units?

Mr. Fitter — For the electricals, we will lock out and tag out breakers supplying this furnace. As far as instrument air goes, there is only one pneumatic valve. We'll probably leave it connected. The natural gas supply to the furnace will be blocked in and blinded at the supply header.

Mr. Timer — Will these disconnections affect other units?

Mr. Fitter — I don't think there's any problem. We've shut down furnaces in the past and it hasn't bothered the other units. Isn't that right Mr. Chem? [*Nods yes.*]

Ms. Green — O. L., you said we can ask What-If questions. Mind if I propose some now?

Mr. Timer — No, go ahead. I'm glad you have other questions.

Ms. Green — What if the electricians lock out the wrong breakers or remove the locks at a later time?

Mr. Fitter — As far as the wrong breakers, operations checks the lockout before maintenance touches anything. And maintenance wouldn't remove the locks unless told to do so.

Mr. Timer — But you don't plan to reactivate this furnace, at least not as far as we can see. Seems to me that you should just deenergize the breakers. No reason to even have the possibility of an electrical hazard.

Mr. Chem — I guess I agree. That way we won't have to worry about energizing a dead line in error. [*Mr. Timer writes the recommendation on his flip chart.*]

Ms. Green — What if the air line to the pneumatic valve leaks? And what if there is a pressure surge on the gas supply header?

Mr. Fitter — Instrument air leaks usually cause control problems in the affected component. Otherwise, they don't do anything. Even a rupture of the air tubing to this valve shouldn't bother the other furnaces.

Mr. Chem — I'm not so sure. Leaks, okay. But ruptures? I think we should blind off the air supply at the header. [*Mr. Timer notes this.*] Natural gas pressure surges would be an operational problem. In the past, surges have caused all four furnaces to run hot for a short time, but nothing else happened. With only three furnaces, a surge may lift a flame off the burner and cause a trip, or it may cause the furnace to hit the high temperature trip setting. I'll need to look into this area. [*Recommendation noted.*]

Mr. Timer — Any more What-If's?

Mr. Fitter — What if Ms. Green quits asking questions, will we finish early today? [*Everyone laughs.*]

Mr. Timer — Will you disable safety features as part of the shutdown/decommissioning?

Mr. Chem — No. Each of the four furnaces has a separate set of interlocks. The interlocks for the other three furnaces will remain active throughout the decommissioning.

The What-If/Checklist Analysis continues throughout the day. The following is the last part of the review and the dialogue from the close of the meeting.

Mr. Timer — Okay, we've now got the tube bundle out and at the maintenance shop. The last major activity is to clean the tube bundle and ship it out. Let's see, are the cleaning materials reactive with any of the process materials?

Mr. Fitter — No, we've cleaned the tube bundles before with no problem.

Mr. Timer — How about switching cleaning solutions. Are less hazardous cleaners available?

Mr. Fitter — I think ABC looked into this a few years back when the environmental group was pushing all plants to review hazardous material inventories. We decided then that the cleaner we are now using is fairly nonhazardous.

Ms. Green — I don't have any problems with their cleaner from an environmental perspective.

Mr. Timer — Do you require protective clothing or special handling of the cleaner?

Mr. Fitter — Yes, we do, but because of the EDC and VCM in the tubes, not because of the cleaner. We will conform to the appropriate regulations when cleaning the tube bundle.

Mr. Timer — Any possibility you'd use the wrong cleaner?

Mr. Fitter — No, we've cleaned furnace tube bundles several times without a hitch.

Ms. Green — What if the wrong cleaner is used? Could a worker get hurt?

Mr. Fitter — I don't know. Depends on the cleaning solution.

Ms. Green — But there are other cleaners in the shop? [*Nods yes.*] I recommend someone review what cleaners are present to see if serious accidents could happen. [*Mr. Timer notes this recommendation on his chart.*]

Mr. Timer — How about disposal of the cleaning solution?

Mr. Fitter — The dirty solution is collected in 55-gallon drums, labeled, and shipped to a waste facility for disposal.

Mr. Timer — You said earlier the cleaning solution is not combustible, right? [*Nods yes.*] Any more questions?

Ms. Green — What if the tubes are not properly cleaned?

Mr. Fitter — The cleaning is done mainly to reduce any chance of employee exposure to EDC/VCM. We will fill the tube bundles with desiccant and seal them before shipment. If there is residue, it shouldn't matter since this bundle will serve as a spare for the VCM furnaces at the Somewhere plant.

Ms. Green — I think we should test for proper cleaning for two reasons: first, the tube bundle may be used in some other service and the residue may present a safety hazard, and second, we'll have to ship the bundle as a hazardous material at great cost if we don't prove it's clean. Besides, if a shipping accident occurs, we don't want to be publicized as having "spilled" a hazardous material. [*Mr. Timer records the recommendation.*]

Mr. Timer — Any more questions? [*Pause.*] Okay, let's quickly review the recommendations to be sure I got them all. [*Mr. Timer reviews the recommendations recorded on the*

chart pad.] Well, I appreciate everyone's input. Mr. Fitter, as we discussed at lunch, I'll document the results of the review and, after the team has okayed the report, you'll follow up on the recommendations.

Mr. Fitter — Agreed.

20.3 Discussion of Results

The What-If/Checklist Analysis results consist of the table of checklist items covered in the review, as well as a table of recommendations (Table 20.2). The table of recommendations was generated by Mr. Timer from the notes he recorded. Mr. Timer recorded only answers to Checklist or What-If questions for which the review team recommended changes. He did note in the HE study report that all the items on the Checklist, as well as many What-If questions, were examined in the review.

20.4 Follow-Up

The review team identified several issues and made several recommendations that ABC should examine before beginning the decommissioning. These issues and recommendations were reviewed by all the team members before they were transmitted to Anywhere's VCM plant manager. The plant manager accepted all of the recommendations and assigned Mr. Fitter the job of following up on these items. The decommissioning is scheduled to occur in three months. Mr. Fitter assigned the recommendations to various personnel at the Anywhere plant and, using a computerized tracking system, checked on the resolution of each recommendation weekly until all the recommendations were addressed.

Table 20.2 Sample Recommendations from the What-If/Checklist Analysis of the Furnace Decommissioning

• Request a unit supervisor, area maintenance manager, and plant safety coordinator review the decommissioning plan
• Disconnect power from the breakers supplying electricity to furnace No. 4
• Install blinds on the instrument air line to furnace No. 4
• Examine the impact of natural gas supply pressure surges on the three operating furnaces
• Review the cleaning solutions used in the maintenance shops to determine if any are incompatible with EDC/VCM
• Develop a plan to ensure the tube bundle is adequately cleaned for shipment

20.5 Conclusions and Observations

Mr. Timer ran an excellent What-If/Checklist Analysis of the decommissioning plan. All the team members participated throughout the day. It is interesting to note that the two team members least familiar with the furnace identified the most recommendations. Their knowledge of safety and environmental hazards, along with their inquiring natures, helped uncover a number of issues that might have otherwise been overlooked. The time required to perform this What-If/Checklist Analysis is summarized in Table 20.3.

Table 20.3 Decommissioning What-If/Checklist Analysis Staff Requirements

Personnel	Preparation (hr)	Evaluation (hr)	Documentation (hr)
Leader	4	8	16
Team Member[a]	1	14[b]	1

[a]Average per team member.

[b]This includes time required by two analysts to research the answers to several questions that arose during the review.